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BARBETS, AND THEIR DISTRIBUTION.

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(With a Coloured Plate.)

In my notice of the Bell-bird and its allies,* I spoke of the difficulties hitherto experienced in the introduction of living representatives of the great fruit-eating families of birds of the tropics into this country, which, however, we had recently succeeded in overcoming in several instances. A case in point is that of the Barbets—a tolerably numerous and well-defined group of zygodactyle birds inhabiting the tropics of both hemispheres, of which, as far as I am aware, no living example had ever been imported into Europe prior to the arrival of the specimen figured in the accompanying illustration. This bird, although not by any means one of the largest or finest of the "Bucconidæ," as the family to which it belongs is termed, is of interest as representing a form hitherto unknown in our aviaries, and as being endowed with special modifications of structure to adapt it to a peculiar mode of life. First, therefore, I will state what is known of the life history of the present species, and its immediate allies. Then I will endeavour to point out some of the principles which are exemplified by the geographical distribution of the group to which it belongs.

The Blue-cheeked Barbet was first described by the veteran ornithologist Latham in the latter end of the last century, and provided with the not very specially appropriate name *Asiatica*. Latham regarded it as a kind of Trogon, and, as Trogons were in those days supposed to belong to America exclusively, called it the "Asiatic Trogon, *Trogon Asiaticus*." This specific name, however, being the first given, we are compelled, in compliance with the general usage of natural-

* Intell. Obs., vol. x, p. 401.

ists, to adopt for the bird, referring it at the same time to the correct genus *Megalæma*. Subsequently to Latham's description this Barbet was figured by the French naturalist Le Vaillant in the second volume of his large illustrated work "On Paradise Birds and Rollers." It has likewise been provided with other names by different writers on ornithology, with an account of which we need not trouble our readers.

The native country of the Blue-throated Barbet is the eastern portion of British India. It is found throughout Lower Bengal, and extends northwards along the sub-Himalayan region, as far as the Dehra Doon and Kumaon. Eastwards it occurs in Assam and Sylhet, but is stated to be rare in Arracan and Tenasserim.

Within this area the present bird would appear to be rather an abundant species, and to have attracted the notice of many of the Indian field-naturalists, who have furnished us with some interesting observations on its habits. Professor Sundevall, whose notes on the birds met with in the vicinity of Calcutta have been translated by the late Mr. Strickland, tells us that this Barbet is common near that city in the months from February to May, and feeds on berries, which were always found broken in its stomach. It is a solitary bird, and like others of the same genus, remarkable for its loud note, which "may be expressed by *rokurog! rokurog!* the middle syllable being uttered in a higher key than the other two. Both sexes cry in the same manner, sitting still, with outstretched neck; at intervals they were seen to spring aside, or transversely across the branch, with considerable activity."

Major Pearson remarks that this species is common in Bengal, but less so in Orissa, and that he did not observe it at Juanpore. "It has a peculiar habit, when perched, of bowing the head, accompanying each motion with a single note resembling the word *hoo*. It has two broods—one in the month of May, the other in November."

Mr. F. Buchanan Hamilton, in his MS. notes quoted by Mr. F. Moore, states that the Bengalee name of this bird is "*Bassunt bari*," or "Old Woman of the Spring," probably from the noise that it makes at this season of the year. He gives its food, as "wild figs, plantains, and other fruit."

Lieutenant-Colonel Tickell, a well-known Indian field-naturalist, has described the nest of this bird as hemispherical, composed of dry grass, and placed externally upon a tree. But there can be no doubt that he has been misled on this point, for all the Barbets nest in holes of trees, and, like other birds that lay their eggs in similar situations, produce white eggs, and it is hardly possible that this species should prove an exception. Indeed, we are told by another equally

trustworthy observer,* that the Blue-cheeked Barbet "excavates holes in trees for its nest."

Besides the Blue-throated Barbet, some eight or nine species of the same genus are found in India. About fifteen others are known, all of which inhabit different portions of the "Indian Region," that is South-eastern Asia and the large adjacent islands of Sumatra, Borneo, Java, and the Philippines. There are also found within the same area two other nearly allied forms of slightly different structure, namely, *Psilopogon*, with one species peculiar to Sumatra, and *Megalorhynchus*, with two species found in Malacca, Sumatra, and Borneo. We have thus altogether about twenty-six known Indian species of this family, which in their habits and mode of life do not materially differ from *Megalæma Asiatica*.

In the forests of Africa we again meet with numerous representatives of the same family, belonging, however, according to the best authorities, to genera different from those of Asia. These are the Barbets of the genera *Barbatula*, *Gymnobucco*, *Læmodon*, and *Trachyphonus*, which are distributed over the wooded districts of Abyssinia, and the adjacent portions of East Africa, are found throughout the tropical forests of Western Africa, and extend southwards nearly to the vicinity of Cape Town. The well-known African traveller and naturalist, Theodor von Heuglin, has written an excellent article upon the Barbets of Eastern Africa, in the "Ibis" for 1861,† and M. Jules Verreaux, of the Jardin des Plantes, has given a complete list of the known African species of the family, in the Zoological Society's "Proceedings" for 1859.‡ From these authorities it would appear that there are at present known about twenty-five African Barbets belonging to the genera above mentioned. We have no such accurate account of the habits and manners of these birds as of the Indian Barbets; but from the following general remarks of Heuglin there would appear to be little deviation on these points. Of the Barbets of Eastern Africa, Heuglin says: "With the exception of the *Trachyphoni*, the *Capitonidæ* are not shy birds, though quiet and solitary, and always keeping to the high trees and bushes. The *Trachyphoni* are frequently seen in the plains, and although also shy, are of a much more lively and wandering nature than the *Pogonorynchi* and *Barbatulæ*. The note of the *Trachyphoni* is loud and very melodious; they run (though in a different way from Woodpeckers) up and down the trunks of trees, feeding upon insects, berries, and fruits, as they hop

* Buchanan Hamilton.

† See his article on new or little-known birds of Eastern Africa, "Ibis," 1861, p. 121.

‡ P. Z. S., 1859, p. 393.

from branch to branch. Their flight is short, but rapid; their course consisting of a series of numerous undulations. I never saw any of the species of this group on the ground. I am not acquainted with the mode of propagation of these birds, except that *Trachyphonus margaritatus* builds in holes of trees, and lays white eggs, usually from four to six in number. In the months of October and November, I have often seen half-fledged young ones of this species clustering together, in the peculiar way that may be observed in some of the European genera (*Parus*, for instance), and sitting on the smooth side of the small branches, chirping as they await their parents. With raw flesh and hard and soft-boiled eggs, I have kept some of them a long time in confinement."

"The *Capitonidæ* of North-eastern Africa are not exactly migratory, though they appear at the time when the Sycamores (*Ficus sycamorus*) are ripe in countries where they are not generally met with."

On crossing over the Atlantic to tropical America we again meet with Barbets of organization and habits nearly similar to those of the Old World, but neither so widely distributed nor so abundant in species as their brethren of Africa and Asia. Only two forms of American Barbets are yet known to science, namely the genera *Capito* and *Tetragonops*, the former with fourteen and the latter with two species.* The latter is the most aberrant form of the whole family—that is, that which departs farthest from the general character of the group—and shows many points of resemblance to the Hill-toucans (*Andigenæ*). There can be no question, indeed, that the Barbets are closely allied to the Toucans (*Rhamphastidæ*), and should be placed next to them in the natural series; and to those who hold the doctrine of the derivative origin of species, it is interesting to note that the most Toucan-like Barbets inhabit the same region as the most Barbet-like Toucans.

It appears, therefore, that in the case of the Barbets, we have an instance of members of the same natural family of birds being met with in the tropics of both the Old and the New World. And this is a very noteworthy fact, for it must be recollected that, as a general rule, the avi-faunas of these two regions—that is, the general series of the birds which inhabit them respectively—are perfectly distinct from one another. Not only are the species—if we except some few wandering forms of nearly universal distribution—invariably distinct from one another, but in nearly every case these species are referable to different genera, and, as a general rule, it may even be stated that the most characteristic birds of these two regions

* See the Author's articles on the American Barbets, in the "Ibis," 1861, p. 182; 1862, p. 1; and 1864, p. 370.

belong to different families. For example, humming-birds (*Trochilidæ*) are very numerous all over the Neotropical Region—under which name are comprised Central and Southern America—but are quite unknown in Asia and Africa. In the same category we may place the toucans (*Rhamphastidæ*), Jacamars (*Galbulidæ*), motmots (*Momotidæ*), puff-birds (*Bucconidæ*), curassows (*Cracidæ*), tinamous (*Tinamidæ*), and numerous other families which are more or less generally distributed throughout Central and Southern America, but are not found in the tropics of either Africa or Asia. In the same way, the bee-eaters (*Meropidæ*), hornbills (*Bucerotidæ*), rollers (*Coraciidæ*), sugar-birds (*Nectariniidæ*), honey-guides (*Indicatoridæ*), orioles (*Oriolidæ*), and other families, are characteristic groups of the ornithology of the Old-World tropics, but are not known to exist in the New World. The cases where members of the same natural family of birds are met with in the tropics of both hemispheres are mostly those in which the families are of extended geographical distribution. For example, the falcons (*Falconidæ*), owls (*Strigidæ*), swifts (*Cypselidæ*), swallows (*Hirundinidæ*), and thrushes (*Turdidæ*), are widely diffused families, which are represented in every part of the earth's surface, and are abundant in the tropics of both the Old and the New World. In the same category may be placed most of the families of waders and water-birds, which are usually of very wide range—in some few cases even the same species occurring in every part of the world. But it is quite an exceptional case for a family of birds confined to the tropics to be found in both hemispheres, and besides the Barbets, the only well-defined families presenting the same phenomenon of distribution are the parrots (*Psittacidæ*) and the trogons (*Trogonidæ*). Members of both of these groups, as in the case of the Barbets, are found in the tropics of Africa and Asia as well as in those of America.

Now, assuming the derivative origin of species—that is, the descent of the various members of natural groups (whether we call them genera or families) from a common ancestor at a more or less distant epoch, let us see what deductions may be derived from these facts of geographical distribution.

In the first place, looking to the general diversity of the avi-faunas of the tropics of the two hemispheres, it is evident that the lands which constitute their seats must have remained, as they now are, for a long period of ages, separated by an extensive barrier of ocean. Upon no other hypothesis than this can the number of extensive groups peculiar to each of them, and the general dissimilarity of the two avi-faunas, be explained.

But on the other hand there must have been a time when

these two regions, now so widely separated, were linked together by an intervening band of tropical land. In no other way can we account for the presence of Barbets and trogons in the tropics of each hemisphere. It is hardly possible to imagine that the common ancestors of these two families, which from their whole organization are essentially denizens of the tropics, were themselves extra-tropical. In the case of the parrots, however, we have probably to deal with a very ancient and long-enduring stock, which may have been formerly cosmopolitan,* and members of which are even now found in the temperate regions of the southern hemisphere.

ON THE STRUCTURE AND MANNER OF GROWTH OF THE SCALES OF FISHES.

BY JONATHAN COUCH, F.L.S., C.M.Z.S., ETC.

Of the vast number of the known species of fish, amounting to several thousands, a large proportion have the body covered, and in numerous instances the head also, with scales; which, for the most part, are so arranged, as to form an armour of defence, as well as an adornment of beauty, that grows with their growth without an increase of number, and by its permanency differs in essential properties from those scales—not very unlike in appearance, and even in some of their uses—which clothe the bodies of reptiles; but which latter, when once formed, are incapable of growth. To enable them to be accommodated to the increase of bulk of the animal, these latter must be thrown off, together with the skin that bears them, to be succeeded by another crop, which is altogether new—a circumstance that does not take place in any species of fish with which we are acquainted. There is, therefore, a much closer relationship between the scales of fishes, of which we have now to treat, and the spines and plates, however otherwise unlike, which we find scattered over or covering the bodies of some other families of fishes, especially as regards their mode of increase in size—a fact to which, on another occasion, our attention will be directed, as showing an example in which an apparently different result is obtained by a simple

* Groups of general distribution over the whole world's surface, such as the falcons (*Falconidæ*), and the ducks (*Anatidæ*), are called "*cosmopolitan*." Groups confined to the tropics, rich as the barbets, trogons, and parrots, may be called "*tropicopolitan*." Another class of natural groups is confined to the northern portion of each hemisphere, and may be termed "*arctopolitan*." Such are the awks (*Alcidæ*) and the grouse (*Tetraonidæ*).

variation in the order of proceeding. But for the present our inquiry is addressed to that kind of organization which we designate a scale, and of which the intimate structure and manner of growth have obtained little notice from naturalists, although in their nature they are well worthy of inquiry. The illustrious Cuvier had directed his attention to the subject, and with some degree of success, as was certain to be the case with whatever he took in hand. But it is apparent that his observations are not in all cases to be relied on; and from what appears in the translation of his "Animal Kingdom," there seems reason for believing that they were not made over a wide extent of the families of fishes that had passed under his notice. But the interest of this subject is such as to deserve a more intimate examination; and so much the rather, as in its pursuit we may find it to assist us in ascertaining something of the affinity of what might appear distantly removed species; and also it may point out some adequate explanation of the fact, that some sorts of fishes, even in families well supplied with this clothing, have them altogether concealed within a smooth and soft skin, and others nearly related to them are altogether destitute of them. In this latter case we may remark, that in many instances the internal and external layer of the skin are separated by a thickened layer of what may be termed a *retè mucosum*, or soft cellular network; in which case the surface of the body remains moist for a longer period when it is exposed to the air; and this may be the cause why some fishes are capable of living long when out of their native element. Experiment has shown that there are fishes which speedily become lighter in weight when exposed to air, while others diminish but little. There is reason also for believing that if some fishes, when out of the water—of which, as an instance, some of the blennies may be mentioned—be frequently wetted over the surface of the body, to the exclusion of the gills, the skin alone will perform a function that shall long sustain the life. It would even appear that such is the case also with some fishes which cannot properly be said to be without scales, although generally so regarded—as the common eel, in which they lie embedded beneath the surface, but are visible on close inquiry, and of which a satisfactory magnified representation is given in the Honourable Mrs. Ward's "Microscope Teachings," Pl. V., Figs. 8, 9; but nothing similar has been discovered in a fish so closely resembling it as the common conger. It is in remarkable contrast with this that the power, one of the Gadoid fishes, becomes deprived of its scales very readily; while the ling, which belongs to the same family, is not furnished with scales, so far as we are able to ascertain; and the megrim, or scaldfish among the flat fishes

(*Pleuronectidæ*), is rarely seen with a scale on it, while others retain them firmly, and again others of the same family are not possessed of any. The anchovy loses its scales so readily, that Belon, who was an observant naturalist, believed it to be without them. The herring also, and pilchard, will lose them without much violence, but the shads, which are of the same family, retain them rather firmly. But whether held loosely or firmly, in every case the scales of a fish are clothed to their free borders where there are such, with the common skin, of which a duplication is carried over that border to the lower surface, so far as it remains free; by which it is arranged that each scale becomes enclosed within a case or cell, of which the anterior border is overlapped by the next preceding one, and the firmness with which it is held depends chiefly on the extent to which it is thus overlapped. The cuticle which covers the more exposed and looser portion of the scale is sometimes exceedingly thin, and therefore feeble; but it is the portion of the surface which furnishes the colour, and from which, in some degree, the substance of the scale obtains its nourishment and growth, although this latter is chiefly from a lower and less coloured portion of the case or cell. In some instances the scale itself, and also its covering skin, are so transparent, especially in individuals of early growth, that an exudation and deposit beneath it becomes conspicuous through its substance, of which we shall produce some examples. But the growth or expansion of a scale, as the fish advances in size, is the more material property of its nature; and this, on close examination, will be found to have its source of nourishment and increase from about the middle of its surface, and from which it spreads itself on all sides, although in a greater degree to its free edge and its root, which latter lies forward in the direction of its body. It is at about this middle portion of the scale, but varying a little in situation in different species, that we discover an organized disk, into which, as we can perceive in the larger scales of fishes, there are vessels inserted, and those not always of a very minute size; but those that pass to each surface of a scale may be distinguished from each other, as well in arrangement as capacity; and it is from this circumstance we draw the conclusion that the scale itself consists of a double layer, like that of the nail of the human finger and toe; although, in the generality of instances, the structure is too fine to allow of our obtaining a positive proof of the fact.

The examples which will be selected for description will illustrate these remarks; but although there is a general resemblance in the marking of the scales of each species, the outline of their shape is found to vary much according

to the part of the body from which they are taken. Those which clothe the back, and especially nearest the head, are the smallest, and they are often oblong and crooked; and those along the line of the belly, especially in the pilchard and sprat, are of singular shape. Our examples, therefore, as offering the best illustrations of the growth and character, are taken from the side, where the outline is the most regular and the structure most easily discerned. In general, the scales of the lateral line are nearly alike in each family, but with a subordinate variation that renders them in some degree peculiar to the individual species, as we shall notice in the common sea-bream, *Pagellas Centrodontus*. The special purpose of the structure which so generally marks the scales of the lateral line is to secrete and pour out a peculiar fluid, that is intended to lubricate the general surface, so as to enable the fish to pass the more smoothly through the water, and perhaps also to secure it from any ill effect of the fluid in which it swims; and it is observed that this mucous does not speedily diffuse itself amidst the surrounding water. Those fishes which have few or no marks of this structure in a lateral line, or which seem to require an additional supply of this lubricating fluid, are also provided with additional pores about the head and mouth for the same purpose.

Of the scale of the perch, *Perca fluviatilis*, a representation is to be found in the work "Microscope Teachings," Pl. V., and also of the sole, *Solea vulgaris*. The scales of the perch are of good size in proportion to that of the fish, for the most part wider than long, with a disk rather obscurely marked, more than three-fourths of the length towards the free edge, and from which pass backward toward the covered portion or roof five or six lobes, of which those toward the border are the widest; those in the middle narrow, with their narrowest portions meeting close together at the disk, and all of them showing separating marks of growth. At the free edge are short fine points, from each of which passes back to near the disk a line, of which each is marked with a cross line in succession, as if each had advanced by successive starts of progress. This disk, therefore, appears to form the centre of all its growth, as well in regard to length as breadth, as we shall see it does in every other instance, and conspicuously in that of the *Sciænae (S. Aquila)*. The scales of this latter fish are large, so that in a full-grown example one of them would cover a florin; but in their shape, or on different parts of the body, they vary more than in most of our native fishes. Many of them taken from one fish appear as if they had been injured, and had recovered the injury as by some natural process of vitality. The disk, which is slightly nearer the free

edge than to the root, is large, and covered with apparent orifices, which do not penetrate through the scale; and toward the free edge there are numerous lines or ridges, which come from the disk, each of them being joined to the next by a cross line in regular order. This series of lines ends abruptly at each border of the scale, where it is narrower than in the middle, and from this ending begins a series of fine lines, which encircle the disk, from which portion of these lines the perforations are continued in the same manner as on the disk itself. From the disk again there passes toward its root a large number of diverging lines, of which some are divided in their progress, and each of them is separated from the next by a narrow channel; but such of these diverging lines as are nearest the lines of the border which encircle the disk, end as they approach to them. On all the scales of this fish that came under observation there were apparent marks of the suspension of growth and its renewal; and, in one instance, the disk appeared to extend over the whole breadth of the scale. A large number of fine circular lines, of which about fifty were counted, pass round the disk, and are also marked on or across the diverging lines, or sections, that are carried to the covered root. When fresh from the fish these scales were observed to be smeared or lined with a silvery pigment. The description now given at some length of the scales of the *Sciæna* will apply in its principal character to those of a large number of fishes of somewhat similar shape, with the addition that in several of them, as the river perch, the raised lines or minute ridges which pass from the disk to the free edge, are carried still further forward, so as to form a serrated border, which constitutes a rough surface over the otherwise smooth skin. Such is minutely the case in the comber, *Serranus cabrilla;* the common sea-bream, *Pagellus centrodontus;* surmullet, *Mullus surmuletus;* piper, *Trigla piper;* conspicuously in the top-knot, *Rhombus hirtus*, where the border of the scale is turned outward; but this spicular arrangement is so minute in some species, as the shad, *Clupeidæ*, that its existence might be questioned. The object of it seems to be to afford an additional bond of security to the scale, for the skin is found to pass over these projecting points.

The disk which is thus the centre of extension in growth is not always exactly at the middle of the scale, as it is in the old wife, *Cantharus griseus*, where it reaches across its extent; and the scad, *Caranx trachurus*, top-knot, saury, *Scomberesiox saurus*, and many others; especially including the whole of the cod-fish tribe, the hake; but in many cases, as the perch and sea-bream, the disk is much nearer the free edge, in which case the growth towards the more concealed

root must proceed to a larger extent, and perhaps more rapidly than toward the free border. The raised lines or sections which proceed toward this covered portion of the scale, and to which reference has already been made, are sometimes carried out in a crenated form, as in the sea-bream, and conspicuously in the perch, as also in the *Labridæ* or wrasses, where the common wrass, *Labrus balanus* shows a large number of them, together with an extensive disk; but in some instances those on the side are more lengthened out, and in others, as the pike, *Esox lucius*, and piper, *Trigla piper*, where the number is only three, the middle segment extends beyond the others. The atherine, *Atherina presbyter*, can scarcely be said to have more than one, but the scale of this fish is marked with a structure that forms a special character in another genus, the *Clupeidæ*, the herring, and pilchard, to which, therefore, that fish may seem to bear some distant affinity. It consists in some well marked hard lines, which, behind the disk, pass from one border to the other, but apparently with particular reference to a middle longitudinal depression. These somewhat waved crossing lines are so formed in their intimate structure, that when the scales are in partial decomposition, the separated portions cease to adhere to each other, except where they are brought together at the longitudinal depression which proceeds from the disk.

The scales of the lateral line are those only which require further general remark, and their organization is for the particular purpose of being the channels through which a lubricating fluid shall be conveyed from a secreting order of vessels beneath them to the outer surface. This channel usually lies along the middle of the scale that bears it, with its opening directed toward the tail of the fish; at near its extremity this is often divided into branches, as in the case in the *Sciæna*; but even in the same fish all these branched channels are not exactly alike, and in the sea-bream they have some curious arrangements of direction; their direction being on the upper border of the lateral line, but covered by the scale next before each one, yet through which it may be seen, while the orifice points to the lower border, where it is bent a little, by which means the thin edge of the coverring scale slightly covers the order of the tube. It is thus that the lower side of the tube is above the apparent lateral line, although close to it.

That the conclusions here advanced on the intimate structure of the scales of fishes, and their mode of growth, as well as the affinity of their structure, have not been obtained from very limited observation, will appear from the following list of species that have been subjected to examination; which with

some further particulars of their peculiarities, are given in the order in which they were studied, but with the exception that those of the same genus are now classed together.

Trigla cuculus.—The scales appear obscurely, as if in rows, almost perpendicular to the sides, and not appearing to overlap each other; and yet they lie much as in other fishes, but with the widest part concealed by the skin; so that only the outermost portion appears. On the upper part of the body each alternate row is more raised than the next; but in some parts irregularly so.

In *T. lineata* these lines of scales are much more strongly marked than in *T. cuculus*, as well by their colour as linear arrangement, and in both cases more plainly when they have become dry.

T. gurnardus, T. piper.

Ammodytes Tobianus.—This fish is placed next to the gurnards, because of the somewhat similar arrangement of its scales with that of *T. lineata*, but the rows are more oblique.

Labrus balanus.—A particular formation in the scales of this family is, that not only is the (commonly finely-coloured) skin carried under the fore edge of each scale, but in the form of a membrane it is extended a little beyond it. This covering skin is rather loosely attached to the surface in which it is enclosed; but it is held firmly by a band or process which proceeds from a stout and tough membrane that lies on, and is firmly fastened to, the flesh beneath. In *L. coquus* they are still adhering by a process below them, as in *L. balanus*, although more feebly.

L. cornubicus.

Mullus surmuletus.—The scales are but loosely fastened, and yet the strongest bond is on the under surface of the disk; and toward the free edge there are perforations, and vessels that pass toward the root; among which are two that are larger than the others, and which lie along the lines or channels of the hindmost crenations. These vessels are not clearly marked in all the scales; but it cannot be doubted that they exist in all, and thus they serve to demonstrate, as in other instances, that the centre of action is in the disk. Of the gorgeous colours of this fish, which are in perfection only in life, the yellow of the lines, and also a tinge of red, are in the skin covering the scales, the yellow being especially over the disk; but there is a strong border of bright red in the skin beneath, toward the free edge, and which shines through the transparency of the scale. The more vivid colour of the yellow is also below the scale.

Pagellus centrodontus.—The scales in some degree resemble those of the surmullet, but are smaller; and those of the

lateral spot are somewhat different from the others in some particulars beyond the colour.

Clupea pilchardus.—In all the examples examined there has been found a peculiarity of which there has not been seen anything like it in other sorts of fish, but the nature of which appears exceedingly obscure. It is, that below the lower portion of many of the scales, and not of all, and not always in exactly the same place, there has been a separate very small scale—one or more, even to three or four. They resemble in a considerable degree, both in size and figure, as well as in organization, the scales of the trout; and they never occur behind the middle of the covering scale, while the latter are as firmly fixed as any of the others. One of these small scales only was seen to have points at its edge.

Cluper harengus, Engraulis encrasicholus, Alosa finta; A. squamopinnata, mitri.

Serranus cabrilla, Sebastes norvegicus.

Esox lucius.—A peculiarity is, that the lobes of the crenations at the inner border on the left overlap each other.

Belona vulgaris.—Although the bones of this fish are naturally green, the scales are not so, except from the colour of the skin that covers them.

Pleuronectes punctatus, Rhombus vulgaris.

Salmo trutta.—The scales, as in all of this tribe, are small and thin, with a shining pearly look; the cause of which is not in the scale itself, but it proceeds from a bright deposit or lining on the lower surface, and may be easily removed. Such is the case also with some other fishes, and in the young salmon it appears to be formed at that period of its growth when a migration to salt water has become necessary to its well-being. The scales of *S. trutta* are attached chiefly, if not solely, at the disk, and that not firmly. *S. Fario.*

Scomber vulgaris, Sc. scriptus, Nobis, Ausonia Cuvierii.

Brama Raii.—In the axilla of the pectoral fin is an arrangement of scales formed in the likeness of a moveable cover, and which in size and shape differ from those of the rest of the body.

Naucrates ductor.

Among the fishes of the genus *Gadus* the scales are small, and of the simplest form, which does not require particular remark.

Several kinds of fishes, also, from the Upper or White Nile, have been studied, with the same object, of observing the peculiarities of their scales; but in this they do not differ from our common kinds.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

(*With a Plate.*)

(*Continued from page* 189.)

THE FLINT implements found in the Derbyshire grave-mounds are extremely varied in form, and many of them of the most exquisite workmanship—such indeed as would completely baffle the skill, great though that skill undoubtedly is, of "Flint Jack" to copy. The arrangement, classification, and nomenclature of flints is at present so uncertain, and so mixed up with absurd theories, that it is difficult to know how to place them in a common sense manner. All I shall attempt to do in this present paper—which is intended to describe, generally, the relics to be found in the barrows of Derbyshire, and not to be a disquisition on flints alone—will be to give examples of some of the more usual forms which have from time to time been found, so as to facilitate comparisons with those of other counties and countries. Of *arrow* and *spear-heads* and "*dagger-blades*," almost every known form have, at one time or other, been exhumed in Derbyshire. The engravings here given will pretty well show the most general and best developed shapes. The first represents three barbed arrow-heads, and a dagger-blade, (6 inches long) from Green-Low. The arrow-heads are of the most general types of the barbed variety, but they are not unfrequently found of a longer, and consequently more taper, form. The dagger-blade is of what is usually called the "leaf-shaped" type, and is the prototype of the bronze dagger of a later period. Another, and of perhaps much finer form, is shown on the accompanying plate, Fig. 1. It was found at Arbor-Low in June 1865, and is 5⅞ inches in length and nearly 2¼ inches in width in the centre. In its thickest part it is scarcely

$\frac{3}{4}$ of an inch in thickness, and is chipped and worked with the utmost nicety to a fine edge. It will be noticed that its sides as they begin to diminish, are deeply serrated for fastening with thongs to the haft or handle.* The next illustration shows three of the most usual types of the leaf-shaped arrow-heads—which are here, in each instance engraved of their full size. On our plate is also shown (Fig. 2) a remarkably elegant example. A small disk of flint is also shown on the same plate. The form of this variety of flint instrument (the leaf-shaped arrow-heads) it will be seen differs considerably, ranging from the acutely angled and sharply pointed shapes to those

of a nicely-rounded and egg-shaped form. Pl., Figs 4 and 5 are two characteristic examples of peculiarly-formed flints, which are not unfrequently found in Derbyshire, but the use of which has not at present been satisfactorily ascertained, and which I believe have seldom before been engraved. In a classification of the flints of Derbyshire, and a comparison of their forms with those of other districts, which I am engaged upon, I hope to throw considerable light on the different types, their peculiarities and uses.

Another description again, which appears more intended for throwing than for any other purpose—and which with its sharp cutting edges, and the unerring aim of the Briton must have been indeed a deadly weapon—is frequently found, and is shown on the plate Fig. 6. It is a simple circular lump of flint, an inch and half, or a couple of inches, or more, in diameter; flat on one side, and chipped into a roundness on the other. Scrapers, too, are very generally found, and are of the usual forms.

Flakes, of various sizes and forms constantly occur. These

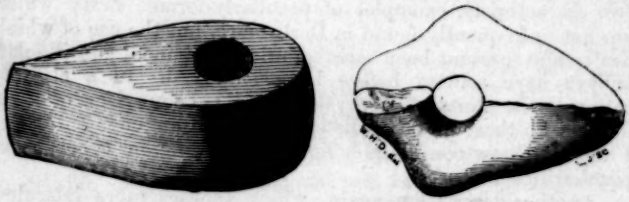
* This fine specimen is in possession of my friend Mr. Lucas.

are frequently called flint knives, or scrapers, but the term is so

indefinite that it is for the present better discarded than retained. Flint celts are occasionally found. An example here shown was discovered in a very interesting barrow, called Gospel Hillock,

at Cow Dale near Buxton,* by Captain Lukis. It measured $4\frac{1}{2}$ inches in length.

The STONE implements consist of celts or adzes, and hammer-heads; the usual form of the Derbyshire stone celt is much the same as the flint example just given, but other shapes do occasionally occur. The examples here given, show three of



the forms of hammer or axe-heads, or mauls, which are found.

In size, these implements vary from three to eleven inches in length.† The usual materials of which they are composed are basalt, quartz-pebbles, argillaceous slate, jasper, green and black schist, sands tone, etc.

Whetstones, spindle whorls, balls of

* See the "Reliquary," vol. viii. (1867).

† The largest found in Derbyshire of which I possess any record, measured 11 inches in length, $4\frac{3}{4}$ inches in width, $3\frac{3}{4}$ inches in depth, and weighed $10\frac{3}{4}$ lbs.

FIG. 1.

FIG. 4.

FIG. 5.

FIG. 3.

FIG. 2.

FIG. 6.

FLINT IMPLEMENTS FROM DERBYSHIRE.

sandstone, querns, triturating stones, capsular stones, and other objects are also found.

In JET, the articles found, consist of beads, rings, studs, necklaces, etc., and some of these are of the utmost beauty. Of these, perhaps the finest examples which have been exhumed are those found by Mr. Bateman at Middleton Moor, at Grind-Low, at Windle Nook, and at Cow-Low.* The accompany-

ing engraving represents the first of these which was found in a barrow on Middleton Moor (near Arbor-Low). In this barrow

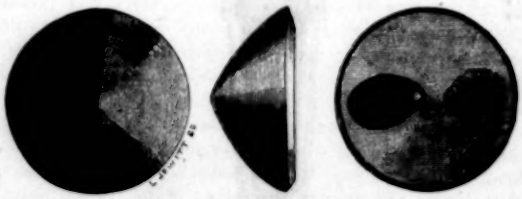
the primary interment was enclosed in a rude stone cist or

† These four examples are engraved in Mr. Bateman's "Catalogue of Antiquities" and "Ten Years' Diggings."

enclosure (here shown) formed of ten rough limestones, and consisted of "a female in the very prime of life and a child of about four years of age; the former had been placed on the floor of the grave on her left side, with the knees drawn up; the child was placed above her, and rather behind her shoulders; they were surrounded and covered with innumerable bones of the water-vole, or rat, and near the woman was a cow's tooth, an article uniformly found with the more ancient interments." Round her neck was the necklace engraved above. It was formed of variously shaped beads and three ornaments of jet and bone, curiously ornamented. The various pieces of this elaborate necklace count 420 in number—348 being thin laminæ, 54 of cylindrical form, and the remaining 18 being conical studs and perforated plates, some of which are ornamented with punctures.

The skull of the woman was so perfect in condition, and was so excellent an example in every respect, that it was chosen as the type of the ancient British female, for figuring in that magnificent work (from which our engraving is taken) by Drs. J. Barnard Davis and Thurnam, the "Crania Britannica,"—a work which is invaluable to ethnologists, and to archæologists in general.

Of Jet studs, the example here given from Gospel Hillock



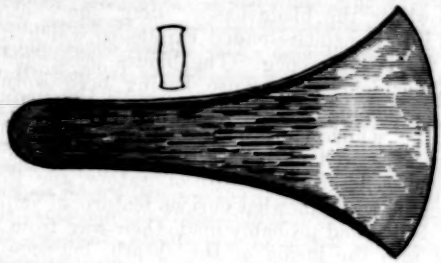
will convey a good idea of the most usual type. It was found along with the flint celt already described.

The implements of BONE found in the Celtic grave-mounds of Derbyshire, consist chiefly of modelling tools, (supposed to

be used in the manufacture of pottery), pins, studs, and other personal ornaments, lance-heads, spear-heads, whistles, (?) mesh-rules, hammers and beads.

In BRONZE the articles found are celts, daggers, awls, pins,

etc. Celts are, however, but seldom met with in barrows, although frequently ploughed up in the course of agricultural operations. Palstaves and socketed celts, etc., are also occasionally picked up. The ordinary form of celt, will be best understood by the engraving here given from an excellent example found in Moot-Low near Dove Dale. One of these celts, of precisely similar form to this one, found in a barrow at Shuttlestone, has been the means of throwing considerable



light on the mode of interment adopted. The barrow contained "the skeleton of a man in the prime of life and of fine proportions apparently the sole occupant of the mound, who had been interred whilst enveloped in a skin, of dark red colour, the hairy surface of which had left many traces both upon the surrounding earth and upon the verdigris or patina coating, of a bronze axe-shaped celt and dagger, deposited with the skeleton. On the former weapon, there are also beautifully distinct impressions of fern leaves, handsful of which, in a compressed and half-decayed state, surrounded the bones from head to foot. From these leaves being discernible on one side of the celt only, whilst the other side presents traces of leather alone, it is certain that the leaves were placed first as a couch for the reception of the corpse with its accompaniments, and after these had been deposited, were then further added in quantity sufficient to protect the body from the earth."* With the skeleton, besides the celt, were a fine bronze dagger, with two rivets for attachments to the handle which had been of horn—the impression of the grain being quite distinctly perceptible; a small jet bead; and a circular flint. The celt had been, as was evident from the grain of wood still remaining, driven vertically into a wooden handle for about two inches of its length.

The bronze daggers which the barrows of Derbyshire have afforded, vary in length from three to five and a half inches; the larger ones being about two and a half inches in breadth,

* "Ten Years' Diggings."

at their broadest part, where the handle has been attached, from whence they taper gradually down to the point. They are sometimes ribbed or fluted. In most instances, the handle has been attached by three rivets; in some cases, however, only two have been used, and occasionally there is evidence of the attachment being effected by thong or other ligature. The handles were of horn or wood, and were usually semi-lunar, where attached to the blade; in one instance, however, the blade has a "tang" or "shank" which has fitted into the square-ended handle, to which it has been fastened by a single peg. The blades occasionally present contestible evidence of long use, having been worn down by repeated sharpenings. In the instance of the dagger found at Stanshope, which had been fastened to the handle by a couple of rivets as well as by ligatures, evidence existed of its having been enclosed in a sheath of leather, and this example also presented the somewhat curious feature of impressions of maggots, which had probably made their way from the decaying body into the inside of the sheath, between it and the blade, and had there remained, and thus gradually become marked upon the corrugated surface of the bronze.

It is worthy of careful remark, that in no Celtic barrow as yet opened in Derbyshire, of which any record is preserved, has a single article of gold been found. A torc and one or two articles of gold have been turned up by the plough, but none have been exhumed in barrows. It is also worthy of particular note that not a single ancient British coin has yet been known to have been found in the county.

One of the principal features of the Celtic grave-mounds of Derbyshire is the POTTERY, and of this I will now proceed to speak. The pottery of the ancient British period may be safely arranged in four classes,* viz.; 1. *Cinerary Urns* or *Sepulchral Urns*, which have contained, or been inverted over, calcined human bones. 2. *Food Vessels* (so called) which are supposed to have contained an offering of food, and which are more usually found with unburnt bodies than along with interments by cremation. 3. *Drinking Cups*, which are usually highly ornamented. 4. *Incense Cups* (erroneously so called, for want of more knowledge of their use), which are very small vessels found only with burnt bones (and usually containing them) within the large cinerary urns. The pottery was, without doubt, made on, or near to, the spot where found. It was, there is every probability, the handiwork of the females of the tribe and occasionally exibits no little elegance of form and no small degree of delicate

*For articles upon this subject see the "Reliquary, Quarterly Archæological Journal and Review," vol. ii. pages 61 to 70; and Mr. Bateman's "Ten Years' Diggings."

ornamentation. The urns, of whatever kind they may be, are formed of the coarse common clay of the district where made, occasionally mixed with small pebbles and gravel; they are entirely wrought by hand, without the assistance of the wheel, and are, the larger vessels especially, extremely thick. From their imperfect firing, the vessels of this period are usually called "sun-baked" or "sun-dried" but this is a grave error, as any one conversant with examples cannot fail, on careful examination, to see. If the vessels were "sun-baked" only, their burial in the earth—in the tumuli wherein, some two thousand years ago, they were deposited, and where they have all that time remained—would soon soften them, and they would, ages ago, have returned to their old clayey consistency. As it is, the urns have remained of their original form, and although from imperfect baking, they are sometimes found softened, they still retain their form, and soon regain their usual hardness. They bear abundant evidence of the action of fire and are, indeed, sometimes sufficiently burned for the clay to have attained a red colour—a result which no "sun-baking" could produce. They are mostly of an earthy brown colour outside, and almost black in fracture, and many of the cinerary urns bear internal and unmistakeable evidence of having been filled with the burnt bones and ashes of the deceased, while those ashes were of a glowing and intense heat. They were, most probably, fashioned by the females of the tribe, on the death of their relative, from the clay to be found nearest to the spot, and baked on or by the funeral pyre. The glowing ashes and bones were then collected together, and placed in the urn, and the flint implements and occasionally other relics belonging to the deceased, deposited along with them.

The *Cinerary*, or *Sepulchral, Urns* vary very considerably both in size, in form, in ornamentation, and in material—the latter, naturally, depending on the locality where the urns were made—and, as a general rule, they differ also from those of most other districts. Those which are supposed to be the most ancient, from the fact of their frequently containing flint instruments along with the calcined bones, are of large size, ranging from nine or ten, to sixteen or eighteen inches in height. Those which are supposed to belong to a somewhat later period, when cremation had again become general, are of a smaller size, and of a somewhat finer texture. With them objects of flint are rarely found, but articles of bronze are occasionally discovered. The general form of the cinerary urns of the Derbyshire barrows, will be best understood from the annexed engravings.

Their principal characteristic is a deep overlapping border or rim, and their ornamentation, always produced by indent-

ing, or pressing, twisted thongs into the soft clay, or by simple

incisions, is frequently very elaborate. It usually consists of

diagonal lines arranged in different ways, or of "herring-

bone" or zig-zag lines, or of reticulations. This ornamentation is usually confined to the overlapping rim and the neck, and to the upper edge of the rim.

Of other shapes found in Derbyshire barrows, and which, as I have said, are unusual in that county, the preceding and the next engraving will serve as illustrative examples. The ornamentation on each is by the pressing of twisted thongs into the pliant clay. The overlapping rim, it will be seen, does not occur on these examples, one of which has the peculiarity, in its central band, of four perforated loops or handles. In this

latter urn a beautiful "incense cup" (?) to be hereafter spoken of, was found. Possibly these urns were the work of the females of a migratory tribe which was passing through, or making a settlement in, Derbyshire.

The *Food Vessels*, so called, vary considerably both in form, and in size, and in ornamentation, from the very rudest to the most elegant and elaborate. They are generally wide at the mouth and taper gradually downwards from the central band. They are found both with interments by inhumation, and by cremation—more frequently the former than the latter—and

are generally placed near the head of the skeleton. They are generally of from four to six inches in height, and the ornamen-

tation is produced by twisted thongs and other indentations. The form of some of these highly interesting vessels will be best

understood by the engravings here given. The "food vessels" are usually burned to about an equal degree of hardness with the cinerary urns.

The *Drinking Cups* are the most highly and elaborately ornamented of any of the varieties of fictile art found in the Derbyshire barrows. They are found with the skeleton, and are usually placed behind the shoulder. In size they range from about six to nine inches in height. They are tall in form, contracted in the middle, globular in their lower half, and expanding at the mouth. Their ornamentation, always elaborate, usually covers the whole surface, and is composed of indented lines

placed in various ways, so as to form an intricate pattern; and

other indentations. The engravings show two excellent examples,—the first from the Hay Top barrow, and the second from a barrow at Grind-Low.

The so called "*Incense Cups*"—a name which ought now to be discarded—are diminutive vessels which, where found at all (which is seldom) are found *inside* the sepulchral urns, placed on, or among, the calcined bones, and generally themselves also filled with burnt bones. They range from an inch and a half to about three inches in height, and are sometimes highly ornamented, and at others plain.

The three examples here shown, respectively from barrows on Baslow Moor, on Stanton Moor, and at Darley Dale, will

give a good general idea of these curious little vessels which may probably not have been "incense cups" but small urns to receive the ashes of an infant—perhaps sacrificed at the death of its mother—so as to admit of being placed within the larger urn containing the remains of its parent. The contents of barrows give incontestible evidence of the practice of sacrificing not only horses, dogs, and oxen, but of human beings, at the graves of

the ancient Britons. Slaves were sacrificed at their master's graves, and wives, there can be no doubt were sacrified and buried with their husbands, to accompany them in the invisible world upon which they were entering. It is reasonable, therefore, to infer that infants were occasionally sacrificed on the death of their mothers, in the belief that they would thus partake of her care in the strange land to which, by death, she was removed. Whether from sacrifice, or from natural causes, the mother and her infant may have died together, it is only reasonable to infer from the situation in which these "incense cups" are found, (either placed on the top of a heap of burnt bones or inside the sepulchral urn containing them) and from their usually containing small calcined bones, that they were receptacles for the ashes of the infant, to be buried along with those of its mother.

(*To be continued.*)

THE STRUCTURE OF THE ANNELIDS, WITH A CRITICISM ON QUATREFAGES.

By Edouard Claparede.

M. Claparede has kindly sent us a pamphlet on the above subject.* It is taken from the introduction to a work on the Annelids of the Gulf of Naples, now in the press under the auspices of the *Societé de Physique et d'Histoire Naturelle de Genève*. M. Claparède spent six months at Naples during the winter of 1866-7, and found the locality extremely favourable for the study of Annelids. He observes that his remarks were facilitated by the recent publication of two works, one by M. Ehlers, and the other by M. Quatrefages; although, in addition to other defects, he found the book of the latter full of typographical errors to an extent "passing imagination," and likewise of false citations. Only one part of M. Ehler's work has appeared. It relates to certain Nereids of the Adriatic, and does not correspond with the generality of its title—a "Treatise on the Annelids." What M. Ehler has done, M. Claparède pronounces to be a "model of exactitude." "L'Histoire Naturelles des Annelés," of M. Quatrefages, is a treatise on the Polychætian Annelids, in which the author endeavours to fulfil two purposes—a natural classification,

* "De la Structure des Annélides, note comprenant un examen critique des travaux les plus recents sur cette classe de vers. Genève, Ramboz."

based upon anatomy, and an enumeration of synonyms. In referring to the writings of others, M. Claparède states that M. Quatrefages has "often consulted plates without taking the trouble to read the corresponding text." One instance of this occurs in a mis-description which he gives of Claparède's genus *Pygaspio*, and other instances are given. While admitting that M. Quatrefages's work may be read with advantage, M. Claparède cannot admit that it represents the present state of science, as regards the anatomy and physiology of worms. "Unfortunately, notwithstanding his numerous and profound researches, the author of the 'Histoire Naturelle des Annelés" has too often forgotten that he had predecessors, and that contemporaries were exploring the same ground with an ardour equal to his own." The "personality of M. Quatrefages"—the ridiculous egotism in fact, so noticeable in his works—"is always foremost, even in the narration of facts known twenty or thirty years before his own scientific *début*. . . . How many errors would have been avoided if the author had conscientiously studied the works of Rathke, Della Chiaje, Grube, and others; if he had taken into account the studies of histologists, such as Kölliker, Leydig, etc., he would not then, as he has sometimes done—in the structure of the branchiæ, for example—have made science retrograde to the epoch of Pallas." "Why did M. Quatrefages, who is so well acquainted with Annelids, describe genera and species from specimens preserved in alcohol in the Paris Museum? He must know the uselessness of such a course, and that Annelids can only be properly studied at the sea-side with the help of living specimens. To describe as he has done, *alcoholic varieties*, is to embarrass science with a *caput mortuum*, which it will take years to get rid of."

"*Regions of the Body and Appendages.* After much discussion concerning the value of the external portions of the bodies of Annelids, most recent authors have adopted the nomenclature of M. Grube, who gives the name of *buccal segment* to the segment carrying the mouth, and that of cephalic lobe (*Præstomium*, Huxley) to all that is in advance of it. . . . . M. Quatrefages, taking up opinions previously advanced by Rathke, considers the cephalic lobe and the buccal segment as together forming the head, but he does not adhere strongly to this view, as he most often gives the name head to the cephalic segment only."

"He has tried to introduce a simplification in the nomenclature of the appendages of the cephalic region, by giving the name of *antennæ* to all the appendages springing from the cephalic lobe, that of *tentacles* to those of the buccal segment, and that of *tentacular cirrhi* to those of the first feet, when

they exhibit in a marked manner characters which distinguish them from their homologues belonging to the hinder feet."

"This nomenclature, which at first appears a happy one, has many inconveniences, and is frequently inapplicable to particular species. In the first place, the appendages of the cephalic lobe are sometimes quite different from each other in formation, as well as in structure, on which account most authors have given them different names. What a difference, for example, there is between the palpi (*lateral antennæ*, And. and Ed. Qtfg.) and the frontal antennæ of the Lycoridians. The first are fleshy, many-jointed, partially retractile, filled by the prolongation of the largest nerve in the body; the second are filiform, simple, non-retractile, poor in nerves. An equal distance separates the palpi (Kimberg, and all recent authors) and the true antennæ of the Aphroditians. . . . A second inconvenience of M. Quatrefages's nomenclature is its inapplicability in all the cases in which the anterior segments are very condensed, and in which it is not possible to determine to which segment a pair of appendages belong. . . . The learned Academician, enamoured of his theory, suppresses by a stroke of his pen the buccal segment of the major part of the Sigalionides—at least, he ascribes to them only "an indistinct buccal ring, deprived of appendages." Nothing is, however, more distinct than the buccal segment of these worms, only it carries a pair of feet with their bristles, and cannot be a buccal segment according to the theory of M. Quatrefages. Unfortunately, the author does not know that all the Polynoes have bristles on the segment which he regards as buccal, and that it would be necessary to imagine for them a distinct buccal segment without appendages."

"M. Quatrefages, however, gives a rule difficult of application, but still a rule for the determination of segments and their appendages. The cephalic lobe and the antennæ, he says, receive their nerves from the cerebral ganglion; the buccal segment and its tentacles, from the œsophagal connections; the tentacular cirri, from the ventral ganglionic chain. This proposition cannot be maintained in the face of modern embryology. Schaum had already asserted that, throughout the articulata, each segment is characterized by the possession of a ganglion, and from this principle he denies that the head of the Anthropoda is formed of many united segments. This doctrine was immediately refuted. In fact, the nervous system differentiates itself relatively very late among the Articulata. On the contrary, the appearance of segments—protozonites, as they are called—is, in many cases, the result of one of the first modifications of the blastoderm. These primitive segments unite in groups, and frequently solder themselves together

long before the differentiation of the nervous system; and when this system is developed, the number of ganglions is not necessarily identical with that of the primitive segments. Amongst Annelids, in particular, the formation of a nervous system sometimes follows pretty closely that of the segments—among the embryos of the *Capitelles*, for example—but it is usually later. I do not dispute that among many Annelids the birth and distribution of nerves conform to the rule of M. Quatrefages. But we see that in certain cases it is not the buccal segment only, but also some of the following segments, which receive their nerves from the œsophagal connexions. It is so among certain Aphroditians, Hesionians, etc. . . . . I employ the name *Antenna* for all the appendages of the cephalic lobe; but when two of these appendages spring from the inferior portion of the lobe, and present special anatomical and physiological characters. I, in common with the majority of authors, call them *palpi*. The modified cirri of the buccal and following segments are called in this memoir *tentacular cirri*."

"Without wishing to dilate on the conformation of the feet of the Annelids, I would indicate the relation of the bristles to the tissues environing them. Some authors consider them as enclosed in a pocket which is merely an invagination of the teguments, and others think they are engendered in an internal follicle, and only arrive in a secondary way at the surface. This second opinion is correct. Among the Hesions and others, for instance, the whole bunch of bristles come in a compact form out of a single pedal opening, but in other cases each bristle has its own special aperture. This is especially the case with the flabelliform tufts. The issuing pore of each bristle is not *preformed*. The bristle makes its own perforation, which is easy when the tissues are soft, but it is not so when the worm is protected by a resisting cuticle, and when the bristle, armed with hooks in different directions, might entangle themselves in the tissues, and produce serious rents. In these cases the extremity of each bristle is surmounted with a small provisional apparatus, terminating in a very keen blade, destined to cleave a free way for the bristle, and to avoid tearing. The form of this cutter varies much with that of the bristle, and especially of the hooks, whose passage must take place without tension of the adjacent parts."

Teguments and Muscular Apparatus.—"The teguments are composed of two layers—one internal and cellular (*Corium*, Rathke, *derme*, Quatrefages), corresponding to the sub-cuticular or chitinogenous layer of other Articulata; the other extra-cellular, the cuticle (epidèrme, Rathke, Qtrfg.) sometimes very delicate, sometimes composed of a thick layer of chitin. Up

to the present the teguments have only been carefully studied by Kölliker, to whom we owe many excellent papers on the histology of the Annelids, which are unfortunately quite unknown to the author of the "Histoire Naturelle des Annelés."

"The superficial layer deserves the name which Kölliker has given it. In a histogenetic point of view it belongs entirely to the category of cuticular formations. The subcuticular layer (*hypoderm*, Weissman) which secretes it—often called with Kölliker epithelium—in most cases does not enable us to recognize the boundaries of its constituent cells. The nuclei appear sown with great regularity in a continuous granular layer, as M. Bauer has seen in certain Arthropoda. Whenever the cuticle attains a certain thickness it is seen to be ornamented with two systems of striæ at right angles to each other, or more frequently at about 70°, as noticed by M. Kölliker. The tubular pores (*porenkanale* of the Germans), wherever they exist, are disposed in lines conforming with the striæ. M. Kölliker has been struck with the difference of these pores from each other. Often, he says, they correspond only with a subjacent cell, and he asks if these openings are really homologous with the tubular pores of the Arthopoda, and do not rather resemble the openings of cutaneous glands discovered by Leydig in the Piscicoles, or the hairs of insects and crustaceans. To these questions I can reply in a positive manner that both sorts of pores exist amongst the Annelids. Those which serve for the outpouring of certain secretions appear to exist in all species. In large species they are sometimes of considerable diameter, but usually very limited. Sometimes they are found united in groups. The canalicular pores are much smaller, much nearer together, and have no resemblance to glands. They are only found in species which have a thick skin, and not in all of these. . . . The subcuticular layer—the derme of M. Quatrefages—appears always to contain glandular follicles, and that in all parts, even in the cirri and antennæ. These follicles empty themselves externally by means of the glandular pores. Some only secrete a thick liquid, others engender bundles of little rods (batonnets), and these I have named *bacilliparous follicles*; others only secrete granules."

M. Claparède explains that the bibliography of these bacillary corpuscles is very rich, and he wonders that it has altogether escaped the notice of M. Quatrefages. "Certain families," he says, "have their teguments literally covered with bacciliparous follicles, even in the cirri and the antennæ. This is especially the case with all the Aricians and Spiodians, and a great part of the Chætopterians. Their abundance is likewise remarkable in a crowd of Phyllodocians, and in certain Hesionians. Among the latter especially, their grouping and

their relation to the external pores is very remarkable. The formation of these organs is still entirely problematical. I have sometimes compared them to the cells full of needles of the Turbellarians, and to the stinging organs of the Acalephs, etc., but this is mere hypothesis."

"Tubular glands full of spherical granulations have been pointed out by us in divers Annelids. Sometimes they reach considerable dimensions, particularly among the Lycoridians, and in this case the glomration formed by the junction of glandular tubes was known to old authors and considered to be a sac. M. Quatrefages knew of one of the passages in which I had spoken of these organs, and cited an analogous observation of M. Keferstein, but by a singular blunder, he makes us describe circumvolutions of blood vessels when we spoke very positively of glandular branches (*boyaux*). . . .

Muscular system.—The muscles of Annelids exhibit extraordinary varieties in their histological character. Sometimes they are composed of parallel fibres quite destitute of a nucleus, and at others of fibre-cells furnished with large nuclei. The existence of these fibre-cells of a muscular character in Annelids has been, it is true, denied by M. Schneider; but "although this *savant* is right in the majority of cases, we shall see that the rule suffers certain exceptions in the pharynx of some Nereids, tentacles of many Terebellians, etc. Sometimes the muscular fibre separates into two distinct layers, one axial, the other cortical, as Leydig first observed."

"The 'Historie Naturelle des Annelés' describes between each segment a sort of tendinous raphis, in which the muscular fasciæ insert themselves. These raphids have no existence. It is easy in longitudinal sections of Annelids to see that the longitudinal fasciæ are continued without interruption the whole length of the worm. This is what Blainville, Della Chiaje, Rathke, Meckel, etc., observed. Muscular plates more or less complete, sometimes divide the previsceral cavity into several chambers. Thus the Ophelians, Polycirridians, and many Terebellians, the Aphroditians, and the majority of the wandering Annelids have three divisions in the perivisceral cavity, the Glycercians two, etc."

Digestive Organs.—M. Quatrefages has endeavoured to establish a new nomenclature for different parts of the alimentary tube, the necessity for which may be disputed. Why, for example, in the Syllidians give the name *dental region of the proboscis* to the organ with glandular walls, which does not form part of the proboscis, and contains no teeth.* The

* In a note, M. Claparède says that M. Quatrefages has enumerated certain Syllidians as having teeth in this region, but has mistaken the species, which belong to quite different families.

names employed by other authors such as fleshy portion of the pharynx (M. Edwards), gizzard (Williams), proventriculum (Oersted), appear very preferable. Are there sufficient reasons for rejecting the names *ventricle* and *glands of the ventricle*, employed first by Rathke in reference to the Nereids, and repeated by his successors? Is it necessary to replace them by œsophagus, and salivary glands? . . . Salivary glands are usually more or less connected with the buccal cavity, while the glands in question are often twenty or thirty segments behind it. In certain Annelids the posterior region of the intestine following the biliary region, presents a special appearance. Its walls appear filled with cells containing curious concretions, without doubt destined to be eliminated with the fœces. I call this portion of the intestine the *urinary region*, though it does not appear to contain uric acid."

The Perivisceral and Circulatory System.—We owe to Quatrefages and Williams, especially to the former, a profound study of the perivisceral cavity and of the lymph which it contains. The perivisceral cavity is lined with a delicate membrane which is only demonstrable in large species, and which M. Quatrefages attributes the discovery of to himself. Had he searched the works of Della Chiaje and Rathke, he would have found the membrane and its name. The structure of this peritoneum (*tunica sierosa*, *tunica peritonieale* of Della Chiaje) is subject to great variation. In some species the perivisceral cavity is supplied with vibratile cilia borne by this membrane. Sharpey was, if I am not mistaken, the first to describe it among the Aphroditians, Williams afterwards observed it on the branchiæ of the Glycerians, and I described it throughout their perivisceral cavity. It was also noticed in the Tomopteridians. M. Quatrefages, who only cites *en passant* the observations of Williams, adds that this ciliary movement was known to him long ago in a number of Annelids, and that it may be seen in all species if any trouble is taken. This opinion is not correct. The immense majority of Annelids do not exhibit a ciliary movement in the perivisceral cavity, except at the entrance of the segmentary organs. I only know a perivisceral ciliation in the following groups:—all the Aphroditians, Glycerians, Polycirridians, Tomopteridians, and, lastly, in an abnormal Terebella—*T. vestita*. It is striking that all these Annelids, excepting the little Terebella and the *Aphrodita aculeata*, are totally destitute of vessels, and of these two exceptions, one, the Aphrodita, is an animal of rudimentary vascular system belonging to a vesselless family; the other, the Terebella, belongs to a family in general vascular, but of which, one tribe, the Polycirridians, is vesselless. In presence of these facts, I must regard the perivisceral ciliary

movement as a vicarious circulatory function in animals having no true circulatory system." "The circulation of Annelids is carefully described by Quatrefages, rendering full justice to the labours of Milne Edwards. It is to be regretted he has not shown the same favour to Rudolph Wagner, and Rathke. The distinction which he has established between arterial and venous currents appears to me very just in its leading features. Other authors have had similar opinions—witness the name *nervarteria*, given by Della Chiaje to the ventral vessel, that is, to the aorta, in the sense of M. Quaterfages. The existence of blood corpuscles in the vessels of certain Annelids is now indisputable. M. Quatrefages admits three examples—the Glycerians, Phoronis, and Syllidians. In fact, among the first, the red corpuscles belong to the perivisceral cavity, and Phoronis scarcely preserves its place among the Annelids. But without speaking of the old observations of Rud. Wagner on a Terebella, confirmed by Kölliker, other examples might be cited. In this memoir blood corpuscles properly so called will be described in the Ophelians, Cirratulians, and Staurocephalians.

(*To be continued.*)

THE LUNAR ERATOSTHENES AND COPERNICUS.—JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Before quitting the neighbourhood of the "rampart-work" of Gruithuisen, we shall briefly advert to the region lying W. of it. Here we shall find a deep crater *Bode* (28), nearly 9½m. in diameter, whose wall of 8° of luminosity makes it a conspicuous object. A smaller crater, *Bode* A, lying at a little distance N.W., is equally reflective. Close to *Bode* on the S. is an irregular ring, called *Pallas*, and at some distance W., and in the First Quadrant, another, *Ukert*, which the extreme influence of S.W. parallelism in its neighbourhood has squeezed almost into a square form, and rendered its aspect quite different at the first glance from that of *Bode*. At the foot of its wall on the S.E. is a straight ravine, wider than the generality of clefts, running in a S.W. direction. This I have seen interrupted in the middle by a broad, shallow valley, so as to make it appear like a cutting through the wide bank on either side.

The *Sinus Æstuum* (our H), as limited by B. and M. (who, unlike Lohrmann, have excluded from it the hilly region around *Schröter*) is a depressed, but considerably reflective surface, unique in its way, according to them, from the absence of the

slightest trace of a crater, as well as from its peculiarly level character; its smoothness being only broken by a few long but very low ridges issuing from *Eratosthenes* (29). The comparison of this district with one swarming with minute craters a little E. is extraordinary; and these forms, which would have been here most readily distinguishable, appear to be actually wanting. It must, however, be observed that their predecessor, Lohrmann, has delineated one very distinctly, of which, though his work was before them, they have taken no notice; and Mädler subsequently (1841), when in charge of the great Dorpat achromatic, perceived several not laid down in the map. L.'s crater I found very conspicuous with 5½ inches, 1861, April 18 and 20, May 17, as well as a second, and, perhaps, a third. These inconsistencies, but too frequently to be met with, introduce so much perplexity and obscurity into the question of lunar change, that we look forward with interest and pleasure to the survey now in progress under the auspices of the British Association, the results of which will certainly not be encumbered with similar ambiguities, at least on so considerable a scale.

Eratosthenes (29), a prominent crater, upwards of thirty-seven miles in diameter, and, therefore, equal in area to some of the smaller English counties, is, as our guides express it, the mighty keystone of the *Apennines*, and probably (as they think) the site of the outburst of that unknown violent agency which raised the summits of *Bradley* and *Huygens*. But for the nearness of the still more imposing *Copernicus* (30), it would certainly be the most remarkable feature of the neighbourhood. It is, however, very inconspicuous in full illumination. A great mountain occupies its centre, and the interior of the ring is supported by strong, broad terraces; the former, according to Schr., divides into two branches, and the latter, on the E. side, are in part separated by distinct ravines; a fact which deserves the attention of selenologists, as possibly throwing some light on the mode of their formation. The ring is brightest on E. Here its summit lies 15,800ft. above the gulf, while on the opposite side it only attains 10,900ft., that is, is only a little overtopped by our Etna! Schr. had given these measures considerably less, and probably too small. Lohrmann mentions two peaks, N.W. and S.W., the former the point of junction of the narrow prolongation of the *Apennines*; E. of this point he has placed a small deep crater on the top of the wall, which B. and M. have lowered to the inner terrace; he also speaks of several broad and generally parallel terraces descending as by steps on the exterior, and extending furthest S. The height of the wall from the outside is given by B. and M. as 3200ft. W., 7400ft. E., showing, with as fair a degree of accordance as

may be expected among such irregular surfaces, an interior depression of about 8000ft. This is something entirely unparalleled on the earth, and, at first sight, in connection with the vast extent and height of the ring, would seem to remove the phenomenon out of the reach of terrestrial analogy; when, however, the very different amount of gravity on the Moon, and possibly a very different degree of resistance from cohesion, are taken into consideration, it does not seem necessary to abandon the idea of volcanic action.

On one occasion (1789, Sept. 12), when *Eratosthenes* was a little less than its own diameter removed from the terminator, Schr. observed that a zone forming the extremity of the shadow which then nearly filled the cavity, being the portion which lay on the interior slope of the ring, and, according to his figure, amounting to nearly ⅓ of its whole extent, was noticeably less dark than the rest. This he supposed to be the effect of the commingling of the true shadow with the penumbra, or partial darkness, which arises from the apparent breadth of the Sun, and, therefore, borders every shadow in the solar system, where the Sun subtends a sufficient angle to make it perceptible. This is, of course, the reason why the shadows of all objects in terrestrial sunshine are ill-defined in proportion to their distance from the body which casts them; and this hazy-looking edge, which would be of great breadth on Mercury, where all the shadows would be extremely *woolly*, and imperceptible on Uranus, where they would be almost critically sharp, would, on the Moon, be sensibly equal to what we see on the Earth. But it is most improbable that such could have been the cause of what Schr. observed. The lunar penumbra is, indeed, rendered visible as a narrow border* of diminished brightness where the terminator passes through surfaces making a very small angle with the rays of the rising or setting sun, while they are fully exposed to the direction of our sight; such as the grey levels of the *M. Serenitatis, Imbrium, Vaporum*, and others; or flat-topped elevations of any height; but where the surface is inclined towards the incident ray, as is evidently the case of the inner slope of a crater-ring after sunrise or (as in this case) before sunset, the penumbra could not possibly attain the projected magnitude described by Schr.†—Schmidt (who

* Schmidt gives its theoretical breadth 8″ on the terminator; but practically it will be much less, as the diminished illumination would not be perceptible till a considerable portion of the solar disk was concealed.

† On a former occasion the same observer has recorded a somewhat similar but much fainter grey border along the edge of the shadow, then become very narrow, within the crater *Eudoxus* (17). But in that case, being on the side of the cavity next the Sun, instead of the opposite, the appearance might be readily explained as a true penumbra, or illumination by a portion only of the solar disk, apparently enlarged and rendered more visible by its falling on the gentle slope of the foot of the wall.

does not, however, refer to this) was not unacquainted with such appearances, having noticed them several times in craters (he especially mentions *Copernicus*, *Theophilus*, *Zach*, and *Sacrobosco*), where an ill-defined edge of brownish grey rendered the length of the shadow difficult of measurement, while other perfectly similar craters in the same neighbourhood were free from any such peculiarity. For an explanation he sees no need of having recourse to penumbra or atmosphere; it might be sufficiently accounted for by a multitude of colossal blocks on the crest of the ring, whose narrow lines of shadow cast upon the opposite wall, with their intervening streaks of light, being separately undistinguishable by us, would produce the confused general impression of a diluted border. In this case, he refers to some terrestrial correspondences, such as the shadow of a row of close-set iron spikes on the top of a door or wall, seen from a suitable position and distance; or the shadow of a fringe of ice-ruins and rock-pinnacles falling on a snowy slope, which he once remarked in great beauty from the Wengern Alp; the edge of a mountain shadow, elsewhere sharp, becoming very indistinct when projected on the very obliquely slanting snows of the Silverhorn and Guggi glacier, the employment of a common eye-glass showed the cause to lie in the confused impression of many long, narrow, separate streaks of shade. (We may observe, by the way, that the eye for terrestrial scenery, evident in this great observer, qualifies him in a high degree for the analogical interpretation of the varied aspects of the Moon.)

But though this is a plausible elucidation, it may not be the true key to the mystery. To the objection that it would be difficult to account in this way for so broad a zone of duskiness as Schr. has represented, falling, too, upon a slope inclined in the wrong direction, it might be answered that his drawing was too rough to be trusted in minute details, and that he seems to have satisfied himself too easily upon the subject. But it is evident that more has yet to be explained, and that the point deserves study. Though there is no improbability in the idea that the summit of a ring should be crested with a row of natural battlements or pinnacles; yet these, if close enough to produce a confused half-tone in the part of the shadow cast by the ridge where it lies facing the sun, would in every other position overlap one another so much in perspective as to intercept too much light, and produce a full and defined shade. Here, therefore, a very powerful instrument would so far decide the question that an equal intensity of half-tone along the whole border of the shadow would negative Schmidt's solution. And so would any want of periodical recurrence in the phænomenon—a point which seems to have

escaped attention. Of course, in any comparison of observations, a very close similarity of conditions would be required; but this being fulfilled, the non-appearance of the border would so distinctly point to some unexplained and possibly unsuspected cause, as to invest the inquiry with peculiar interest. Any observer making an especial study of the edges of the interior shadows of great craters might not regret the loss of time in the end.

The position of *Eratosthenes* is in the midst of landscapes of very contrasted characters—the level *Sinus Æstuum*, the towering *Apennines*, the vast extent of the *Mare Imbrium*, and a most remarkable honey-combed district which we shall find to the E. The line of the *Apennines* may be considered as continued through it in that direction by a broken range of hills, of which the extremity, of great steepness on every side, especially N,—the η of B. and M., attains according to them 4000ft.: Schr. had given it 250ft. more. Running S. from the E. side of the wall is a more considerable range, reaching near its beginning, according to Schr., 9500ft., and leading down to a large ring named *Stadius* by B. and M. when they failed in identifying, as has been mentioned, Riccioli's spot of that name. This, 43 miles in diameter, and therefore surpassing in that one respect its overpowering neighbour *Eratosthenes*, is a strange contrast to it in other ways, the embankment, on which they have figured two or three minute craters, being as a whole scarcely 130ft. high, the mere outline of a wall, so as to have escaped the attention of B. and M. for three years. Its surface is not depressed, and the question may possibly suggest itself, Have we here all that remains visible of a great ring, whose height without and depth within have been subsequently reduced to these trifling proportions by a circumfusion and penetration of matter, once fluid or plastic, but now consolidated? The inquiry is thrown out as a mere suggestion for examination and thought, with the sole addition that there are very many other parts of the lunar surface where such a suspicion might as naturally arise. B. and M. remark in its interior only some ridges and one small crater, probably less elevated even than the ring. Of this more hereafter. We next cross the curious district already alluded to, and to be described at a future time, to the magnificent *Copernicus* (30), one of the most imposing and best-developed specimens of its class. There are many its equals or superiors in size and depth in other parts of the Moon, but few more remarkable at once in themselves and their situation; its structure is very perfect, and its insulated position, and the absence of any material foreshortening, exhibit it to especial advantage. The diameter of its colossal wall is about 56 miles. This wonderful rampart, which does

not deviate much from a circular form, bears a comparatively narrow crest, very brilliant, even to 8° and 9°, in full illumination; under especially favourable conditions it appears like a string of pearls, and on one occasion B. and M. believed that they counted upwards of 50 of these probably very minute summits. The highest point on the W. attains 11,300ft., on the E. it is only about 300ft. lower, as measured from the depth below. Schr. had given 9,600ft. The whole breadth of the wall is considerable, and its structure is very complex; nowhere, perhaps, on the lunar surface is the terrace-form more obvious, though some of the ridges can hardly come under that designation, being divided by deep gorges from the central crest. This circumstance, and the serpentine form of some of them, had been noticed by Schr., and beautifully represented by Sir J. Herschel in his "Outlines of Astronomy," where the portrait, though anonymous, may be easily recognized. Between the innumerable ridges which break up the inner slope on the N., Schr.'s 27ft. reflector showed him about 20 minute hills. He remarks that if the interior were inhabited by creatures like ourselves, their journeys would be attended with much difficulty; "but Omnipotence knows no bounds in the manifold organization of its creatures." There is a considerable central mass, consisting of six separate summits, of which two overtop the rest; the small one between them, discovered by Schr., could not be found by him upon a subsequent occasion, but appears in the drawing of H.

Schmidt, who considers this ring as combining all the characters of the class to which it belongs, will hardly be contradicted when he says that "careful studies of this incomparably beautiful and magnificent image alone fully counterpoise those of a hundred other craters." On E. he found the inclination of the crest and some of the terraces amounting in places to 50° and even 60°—a fearfully rapid acclivity—which towards the foot sinks down to 10° and 2°; and on this side he considered it about 12,500ft. high; the W. peak is some 1000ft. loftier still, rising nearly 7000ft. above the convex terraces at its base, themselves ranging 6000ft. above the interior. The latter, he says, is probably concave; the two principal central hills attain, E. 2400ft., W. 2000ft. Even these must require a considerable climb, and command a magnificent view of the surrounding rampart, at a distance of twenty-eight miles on every side. The same observer remarks the absence of minute outbursts on and within the wall, and, also, the general raising of the ground for a long distance—no less than one hundred miles from E. to W., which may be detected when *Copernicus* lies 5° to 10° from the terminator—a very interesting fact, as showing the wide outspreading and probably deep

focus of the mighty force, which ultimately burst, at this spot, out beneath the open sky. We may observe, too, that this probably shows the condition of the surface at that time, neither so hard as to be inflexible under pressure from beneath, nor so plastic as to return to its original level when the eruption came to an end; or, perhaps, that the latter action continued so long that the upheaved area stiffened by degrees into its present form. The exterior height of the wall can hardly be measured with any certainty, the end of the shadow falling on this gradual and very irregular slope; Schmidt gives it, however, on E. about 4300ft. The central hills, it will be observed, lie far below the exterior surface; a fact the general prevalence of which upon the Moon had been already noticed by Mädler. A great part of this surrounding area was found by Schr. to be covered with an innumerable multitude of greyish ridges, especially S. and S.E., there being fewer N. and E., and scarcely any W. (a fact, we may observe, possibly connected with the greater height of the ring on that side, and if so, showing their posterior formation). These exhibited to him, though not as distinctly as the streams around *Aristillus* formerly described, a radiation from the centre. A portion of them has been represented by Herschel, and described as "evident indications of lava-currents streaming outwards in all directions." To travellers from among ourselves, what could be more marvellous than the gradual ascent for some twenty miles among these colossal remains of the ancient fires, while every position of vantage showed us far ahead the abrupt and irregular edge of the crater towering up through many points of the horizon, and assuming as we neared it the most imposing dimensions; this once reached and climbed—a matter no doubt of severe and continued toil—what a display of creative power would burst upon the view; terrace beyond terrace beneath our feet, sloping rapidly down to an enormous amphitheatre as deep, perhaps, as the peak of Mont Blanc is raised above the valley of Chamouni, and encompassed by a circular cliff, the prolongation of our own standing-ground, the opposite side of which would be as distant from our eye as Oxford is from London! But to realize the process by which that gigantic caldron was formed, and the scene which it presented when it was in full action, whatever the nature of that action may have been, surpasses the liveliest human imagination. When at length we could withdraw our eyes from the gulf beneath us, filled perhaps in part with the blackest shade, and could survey the neighbourhood around us, we should find that it comprised much that elsewhere would be deemed of a highly remarkable character; from the rapid rounding off of the lunar globe, the horizon becomes much more contracted

than on the Earth, and the prospects are comparatively limited even from the loftiest summits; but this defect must be somewhat compensated by the perfect clearness of the air, if so it may be termed, and in the present instance, our range of sight to the W. and N.W. might probably comprise the outline of a most peculiar district, already more than once adverted to, and with some yet untold peculiarities of *Copernicus*, to be described hereafter.

TRANSIT OF JUPITER'S SATELLITES.

Nov. 2nd. II. shadow in transit, 6h. 9m. to 9h. II. leaves disk, 6h. 28m.—7th. I. in transit, 5h. 42m. to 8h. 2m. I. shadow ditto, 7h. 1m. to 9h. 20m.—8th. III. shadow leaves disk, 7h. 36m.—9th. II. in transit, 6h. 8m. to 9h. 2m. II. shadow enters, 8h. 48m.—13th. IV. shadow leaves disk, 8h. —14th. I. in transit, 7h. 36m. to 9h. 56m. I. shadow enters, 8h. 57m.—15th. III. leaves disk, 6h. 15m. III. shadow enters, 8h. 3m.—16th. I. shadow leaves disk, 5h. 45m. II. enters, 8h. 44m.—21st. I. enters, 9h. 31m.—22nd. III. enters, 6h. 36m. —23rd. I. shadow in transit, 5h. 21m. to 7h. 40m. I. leaves disk, 6h. 20m.

OCCULTATIONS.

Nov. 6th. λ Aquarii, 4 mag. 10h. 29m. to 11h. 38m.—78 Aquarii, 6 mag. 11h. 56m. to 12h. 47m.—8th. 10 Ceti, 6 mag. 7h. 6m. to 8h. 21m.—12th. 48 Tauri, 6 mag. 11h. 15m. to 12h.

CHARACTERISTICS OF ROTIFERS.

BY HENRY J. SLACK, F.G.S., HON. SEC. R.M.S.

(*With a Plate.*)

THE following paper contains the substance of a lecture delivered by the writer before the Old Change Microscopical Society on the 18th October, and is intended to serve as an introduction to the study of a group of small animals, which from their variety and beauty have always been favourite objects with microscopists of all grades, from young beginners to profound students of natural forms.

We may begin by asking, What is a rotifer? And the answer to this inquiry is rendered somewhat difficult by the important differences exhibited by different members of the group of beings usually designated by the term. If a botanist were asked, What is a *chrysanthemum*, or "golden flower?" he would enumerate a number of qualities amongst which the colour indicated by the name would not be found, because it belongs to individuals and not to the entire group. In like manner a *rotifer*, or "wheel-bearer," may be a creature which does not exhibit the least semblance of wheels or organs presenting an appearance of rotation, and a considerable number of so-called *Rotifera* only retain the name because it has become a popular one, and because they possess other organs and structure more or less closely resembling those of the common rotifer, from whose aspect the whole group was designated.

Formerly, rotifers were spoken of as Infusoria, but Ehrenberg distinctly pointed out the superiority of their organization, and observed a great number of important facts concerning their structure and modes of life. In dealing with this, as with other groups, Ehrenberg no doubt made many mistakes, some arising from erroneous interpretations of what he did see, and others resulting from the imperfect instruments at his command, but it is unfair to notice the errors of this distinguished microscopist without remembering with gratitude the enormous amount of his labours, and the success that has attended a great portion of his investigations.

Returning to the question, What is a rotifer? let us endeavour to obtain a reply by bringing together certain facts pertaining to the wheel-bearing group. Rotifers, then, are symmetrical animals, in which a dorsal and ventral, or back and front sides can be distinguished.* They have a flexible, strong skin, and

* Mr. Gosse says, "the dorsal aspect is always determined by the eye or eyes being turned towards that surface, by the stomach and intestine passing down it, and by the cloaca being on that side of the foot. The ventral aspect has the manducatory apparatus and the ovary."

in many cases enjoy the further protection of a sort of armour, which may be roughly compared to that of the turtle or tortoise, or of dwelling-tubes, more or less simple in construction. They have considerable powers of contracting or expanding their bodies, and in some cases can slide one portion inside another, like the tubes of a hand telescope. Their possession of a certain rank in the animal world is evidenced by a well-marked digestive canal, consisting of an oral or receiving orifice, an apparatus composed of hard materials for crushing and grinding food, popularly termed a "gizzard," though it is not exactly analogous to the grinding organ of birds, a gullet, a stomach supplied with secretions from glandular organs, and, except in one genus (*Asplanchna*), an intestine and anal orifice. The term "oral orifice" has been used instead of the "mouth," to avoid suggesting comparisons which might not be correct between the mouth of the rotifer and that of the higher animals of the vertebrate type. More or less surrounding the oral or receiving orifice, are groups of cilia, which in the common rotifer present the aspect of the well-known "wheels." Most rotifers, if not all, possess rudimentary eyes, either at an early period, or throughout their lives. They have all a distinct muscular system, and a nervous system, of which a large cerebral ganglion is frequently conspicuous. None of them possess a true blood circulation, but all have what is termed a "water-vascular system" of delicate canals, similar to those found in *Turbellaria*, to which the Planaria, well-known to microscopists belong, and in the Helminths, or intestinal worms—flukes, tapeworms, and threadworms. The functions of the water-vascular system are not positively known, but are conjectured to be respiratory and excretory. The contractile organ, popularly called the "heart" of rotifers, belongs to this system, and so do the "vibratile tags" easily seen in some species.

The rotifers were formerly considered to be hermaphrodites, but Mr. Brightwell and Mr. Gosse discovered distinct males of certain species, and it seems most probable that other males will be found in the course of further research. The rotifers usually obtained by microscopists are females, and their eggs and ovaries are frequently very conspicuous, the eggs often being enormously large in proportion to the dimensions of their parents. The common rotifer is an example of ovoviviparous generation, the egg with its living contents being commonly seen in the body of the parent, and the young coming forth as the exact image of its mother. In the common rotifer, and in many others when the eggs are sufficiently advanced, the jaws of the unborn infant may be seen vigorously working, the little red eyes brightly shining, and a strong ciliary current

running down the gullet. Three kinds of eggs have been distinguished—common eggs, intended for immediate hatching; winter or resting eggs, designed for preservation probably till the next season, like the statoblasts of *Plumatella* and other Polyzoa; and male eggs. The winter or resting eggs are usually rough and large.

The known males are shortlived, and not provided with any digestive machinery. They seem to be simply locomotive organs of fecundation, whose services are occasionally required, the ordinary process of reproduction being carried on by the females alone, as is the case with those pests of the greenhouse and garden—the Aphides, or plant-lice. Such a method of propagation has more or less analogy to the multiplication of plants by buds or cuttings, instead of by germs fertilized by pollen and giving rise to true seeds.

The existence of eyes in rotifers has already been mentioned. They often exhibit the brilliance and tint of the ruby, and the single large eye of the *Brachions* may be specially noticed for its conspicuous beauty. In many rotifers the eyes vanish as the individual grows old, and it is often difficult to detect them. Dark ground illumination is frequently very useful for this purpose. The eye is probably of limited use, and may not form true pictures in the highest sorts of rotifers, though a refracting body or crystalline lens is said to be always present. There are many gradations in nature from eyes that seem only capable of making known the presence of light to those which form elaborate pictures on the retina, and by means of appropriate nerves supply definite information to the brain. Probably, the rotifer eye occupies one of the lower, though not the lowest position in the scale.

The calcar or spur of the common rotifer, often seen projecting like a pigtail, and similar organs on other species are probably *feelers*. They are tubular structures, fitted with a sort of moveable piston, terminating in a tuft of cilia. A sense of touch is probably diffused over the soft parts of the body, and the tentacles may be very sensitive to vibrations affecting the fluid in which the animal lives. It is also probable that the sense of taste exists in a rudimentary form, as it is very common to find rotifers rejecting particles which so far as size and consistency goes might be swallowed for food.

No perfectly satisfactory classification of rotifers has yet been proposed. Ehrenberg divided them into groups, founded upon his conception of the form of the rotary organs, but a modification or rather expansion of Dujardin's classification will be found more convenient for general use, and may stand as a provisional arrangement, pending a more thorough examination of the whole series. Dujardin calls rotifers *Systolides*,

from the Greek, *συστολη*, contraction, but as many other creatures exhibit contractibility in as remarkable a way, the name has not usually been considered appropriate, and has not come into general use. He divides his *Systolides*, which include water bears, into orders, as follows:—1. Those which are *fixed* by the posterior extremity of their body. 2. Those which have only one mode of locomotion by means of their vibratile cilia, or the *swimmers*. 3. Those which have two modes of locomotion, and which sometimes crawl like leeches, and at others swim like the preceding, or *swimmers and crawlers*. 4. Those which are destitute of vibratile cilia, but provided with claws and are veritable *walkers*—water-bears. It is desirable to exclude the water-bears from the group, and we shall then have fixed rotifers, swimming rotifers, and swimmers and crawlers. These divisions, though not founded upon any deep considerations of structure, indicate obvious and important facts. The fixed rotifers comprehend the *Floscularians*, which have long tufts of cilia, but no wheel-like organs, and the *Melicertians*, which have four lobes something like the petals of a flower, with cilia round their margins, exhibiting the rotatory appearances. The swimmers comprehend several genera, amongst which the *Brachions*, or pitcher rotifers, are conspicuous. Dujardin proposes two divisions of swimmers, one characterised by a general flexibility of the skin or integument, *Furcularians*, and the other, like *Brachionus*, *Salpina*, etc., having rigid carapaces or cuirasses. The swimmers and crawlers comprehend the *Philodines*, of which the common rotifer is the type. Many things might be said against accepting this scheme as a final arrangement of the group, but no harm can arise from its provisional use, provided that it is borne in mind that in addition to the modes of locomotion mentioned by Ehrenberg, *jumping* must be added as characteristic of several species, such as *Polyarthra*, *Triarthra*, and a few others. It would also be advisable to add to Dujardin's groups one of associated rotifers to include *Conochilus* and *Lacinularia*, which are inconveniently placed in his Melicertian family. There is an obvious and important difference between the permanent fixture, with confinement to one spot, of the *Floscules*, *Melicerta*, *Œcistes*, etc., and the free swimming of the associated groups of *Conochilus*. In both cases the creatures may anchor themselves by their tail-feet, but in one case there is permanence of abode and in the other a roving life.

The fixed rotifers differ very considerably from each other, and those which form simple tubes are easily distinguished from the *Melicertæ*, which are builders, constructing their abode of separate pellets moulded by an organ specially provided for the purpose, and placed in due order as a mason

arranges his stones or bricks. There are also obvious and important differences between the ciliary apparatus of the *Floscules*, which exhibit nothing like rotation, and those of the *Œcistes*, *Limnias*, or *Melicerta*, which do show that remarkable phenomenon, and in which it is subservient to the collection of food. In fact, Dujardin's order of fixed rotifers is so far unnatural, that it groups together families that must be separated in any system founded more upon structure and less upon obvious peculiarities of external appearance.

If we followed Dujardin's arrangement, we should begin by speaking of the *Floscularians*, which would not have been called "rotifers" or wheel-bearers at all, if they had been the first of the group to attract attention. The most conspicuous and decided wheel-bearer is the common rotifer, in which the rotatory organs serve the two purposes of locomotive engines and food collectors, and probably, also, act in assisting respiration by bringing fresh currents of water to the delicate tissues of the creature. When it pleases this rotifer to anchor herself by her tail-foot, her mode of life for the time resembles that of *Œcistes* or *Limnias*. Her ciliary currents cause a convergence of whirlpools, which bring all sorts of particles, living or dead within her reach, and she selects some for reception and others for rejection. This being ended, we find her swimming, or crawling, frequently routing about with the snout-like extremity she presents when her wheels are withdrawn, and apparently exerting discrimination in the selection of places to examine, and of food to take in. From this active, many-motioned animal, with powerful, whirlpool machinery at her command, let us pass to the beautiful Floscule, one of the most exquisite of rotifers, when properly exhibited by dark-ground illumination. If our illuminating apparatus is nicely managed we see an extremely delicate and transparent cylinder like a confectioner's glass, surrounding the creature, and forming her house. Slowly she rises, looking so uncouth that her appellation of "beautiful" seems inappropriate. But we must not be in a hurry to condemn her. Most gracefully she throws out her five lobes, and opens from each one a long tuft of cilia, gleaming and glancing in the light of our apparatus. If we keep quiet, the fans remain expanded and still. Each of the long hairs or cilia, of which it is composed, appears capable of transmitting delicate vibrations, and we frequently see a whole group of them *twinkle* in succession like the small steel vibrators of a musical-box when the instrument is playing. The animal can direct her head to any quarter, she can change at will the position of her richly-ciliated lobes, and thus cause the inward current which she maintains by less conspicuous cilia to bring to her mouth the particles she requires. Here the long cilia may be roughly

compared to the whiskers of the cat—they are collectors of a certain sort of information, not apparatus for catching food. If any object strikes rudely against the long hairs of the Floscule, she returns to her cell; and shaking the table will often induce her to do the same.

Let us now look at the *Stephanoceros*, the finest of all rotifers when seen in perfection, and a most voracious creature. Her cup-shaped body often seems nearly filled with green and golden monads and similar things she has swallowed. The dark ground illumination of the parabola or spot lens, in such cases, makes the creature look like a crystal goblet filled with emeralds and rubies. The five arms are something like the tentacles of the polyzoa, and they bear cilia at their edges. A little examination, however, shows us that the *Stephanoceros* arm cilia are not like those of a polyzoon in constant vibration, but more quiescent, like those of the Floscule. They are also much longer than those of the polyzoa—indeed, much longer than any of the drawings in ordinary books represent them, and much longer than any microscopist will have a chance of seeing them, who does not take great care of his illumination.

In *Melicerta* we come back to the wheel cilia, but the most noticeable peculiarity of this creature is her method of building her tube, which Mr. Gosse was the first to describe, though she was known to Leuwenhoek in 1703. Immediately below the angular chin of the *Melicerta* is a cup-like organ to which a ciliary current can bring particles to be "moulded with the help of some secretion into the pellets of which the little house is built up. Having formed her brick the *Melicerta* bends her head and deposits it in its place."

The tubes of the rotifers we have just considered are *constructions*, that of the *Melicerta* being an example of masonry, while those of *Floscule* and *Stephanoceros* are simpler, consisting of a gelatinous-looking exudation thrown off by the animal in the form of rings. In the case of *Stephanoceros* the successive portions are roughly joined, so that the divisions may be seen in the tubes of this species. In *Limnias* and *Œcistes* the tubes are gelatinous in aspect, and sticky on the outside, so as to cause the adhesion of extraneous particles. In the *Floscule*, the gelatinous-looking matter, whatever may be its chemical composition, is a very perfect transparent hydraulic cement, and the structure it forms is so thin and transparent as to be very easily overlooked.

If we pass from these tube-dwelling rotifers to the associated rotifers *Conochilus* and *Lacinularia* we do not find anything that can be fairly termed a tube. The rounded balls which they present to our notice, are composed of individuals more or less immersed in a gelatinous mass,

from which they escape when inconvenienced, or enfeebled by the pressure and confinement of a live box or compressorium. Probably the greater part of this gelatinous mass has no important action in keeping the colony or family in union—that object seems to be effected by their tail feet, which hold on to a central portion of the gelatinous matter. The different members of a *Conochilus* or *Lacinularia* group are probably, in every case, all one family; but I am not aware that any one has succeeded in watching the whole process of the formation of a group of *Conochili*, though it is not uncommon to find in *Conochilus* balls individuals varying in size and apparent age. When a *Conochilus* group is broken up, the individuals gyrate about as if utterly destitute of self-control. They cannot walk or crawl, and their ciliary apparatus, unlike that of the free swimmers, is not adapted to execute the movements required by an independent being. When in a mass, the *Conochili* revolve, and roll through the water in various directions, and they must have some power of simultaneously modifying their ciliary action, or we should find them collected together on one side of a pond, or continually thumping against one *side* of a glass, which is not the case.

The *Conochilus* is a free swimmer for the greater part of its existence, if not for the whole of it; but *Lacinularia*—which I know only from report—appears to be stationary, except when a young associated brood leave the parent mass, and swim away in search of a fresh location. Single *Lacinularians* are not, it is said, in the habit of making solitary journeys, though they resemble very closely *Megalotrocha*, which is described in Pritchard as "white and free when young, and yellowish and attached in radiating clusters when old."

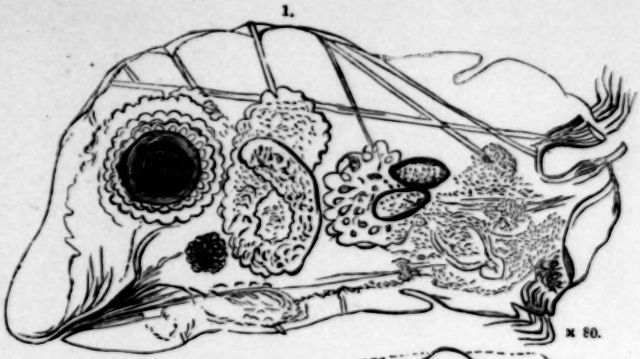
We may now consider Dujardin's "free swimmers," the first section of which are provided with a sort of armour, carapace, or cuirass. He names them from this circumstance "cuirassiers." They comprehend *Pterodina*, *Anourella* (or tailless), *Brachions* (with tails), *Lepadella*, *Euchlanis*, *Dinocharis*, *Salpina*, *Colurella*, *Ratula* (or rat-tail), *Polyarthra*, and *Triarthra*, the former with several sword-like appendages, whence Mr. Gosse has given it the name of "sword-bearer," and the latter with their long styles used for a jumping method of locomotion. *Asplanchna*, of which we shall have to speak presently, belongs to this group. Dujardin describes this order as composed of "animals of variable form, some round and flattened, others ovoid, and either almost cylindrical or compressed, but their length never being more than double their breadth, covered with a membranous cuirass." [The term "membranous" is objectionable, firm or hard would be

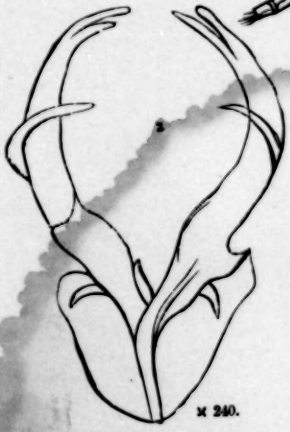
better.] "The cuirass composed of one or two pieces often furnished with salient points, or appendages, either fixed or moveable, and which do not change their shape when contracted. The mouth, furnished with jaws, and preceded by a vestibule, the ciliated walls of which are more or less prolonged into lobes garnished with vibratile cilia presenting the aspect of toothed wheels in motion. Some tailless, others having simple or bifurcate tails."

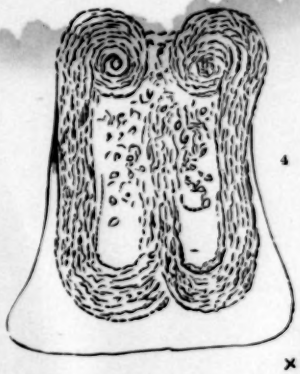
We have to notice in this section the great variety of shape from the common *Brachion*, or pitcher rotifer, which may be roughly compared to a turtle in form, and which is furnished with a powerful tail, that it lashes about like a cat, to the elongated skeleton-like *Dinocharis*, or to *Triarthra* and *Polyarthra*, with their remarkable appendages. In the greater part of this group the cilia which give rise to the rotatory appearances are the chief instruments of locomotion; but those furnished with limb-like appendages use them as locomotive organs in addition to the cilia. *Salpina* is like a prismatic glass box; *Pterodina* like a soup-plate, with a head and tail projecting at opposite sides; and some of the others are very singular in aspect.

We are now engaged merely in getting a general idea of the whole group of rotifers, and pass from the Cuirassiers to the Furcularians, who constitute a distinct family of Dujardin's swimmers. He describes them as "animals with an ovoid or cylindrical body, very contractile and variable in form, covered with a flexible membranous tegument capable of making folds in regular longitudinal and horizontal lines, with a tail more or less long, and furnished with two fingers or styles." This family contains, amongst others, the *Notommata aurita*, or "eared" *Notommata*, so well described by Mr. Gosse, in the "Transactions of the Microscopical Society" (May, 1850), and which shows the water-vascular system and the muscular system in a very striking way. The term "tail" must not always be strictly understood, when speaking of rotifers. In the case of the *Notommata*, for example, Mr. Gosse points out that the so-called tail is a retractile foot with two pointed toes. The chief conditions of belonging to Dujardin's Furcularian family are, being swimmers, not having a rigid carapace, and not being able to crawl as well as swim. The lowest form of this family is almost worm-like (*Lindia torulosa*). Dujardin concludes his second order with the *Albertian* family, comprehending the still more worm-like *Albertia*, in which the ciliary apparatus is feebly developed, and which is a parasite in the intestines of earth-worms and snails.

Dujardin's third order and sixth family include the swimmers and crawlers, and comprehend the common rotifer and other species which strongly resembles it. He describes







ASPLANCHNA BRIGHTWELLII.

them as "animals with club-shaped bodies, able to contract themselves into a ball, and capable, when extended, of drawing in their anterior extremity, or protruding in its place a double lobe with cilia, presenting the aspect of two wheels in motion; terminating posteriorly by a many-jointed tail, the last joint carrying a pair of fleshy fingers or styles. Swimming by means of vibratile cilia, or crawling like leeches by alternately fixing the two extremities of the elongated body. Jaws stirrup-like. Two or more red eye points." We shall presently see the real nature of the jaws so described; but with the mention of the aspect of this family we conclude our brief review of some of the leading varieties of rotifer forms.

Let us now revert to the trochal disks and adjacent ciliary apparatus.

In the first place it may be generally remarked that the ciliary organs of rotifers are more complicated than they may appear at first sight, or than they are sometimes described. An immense difficulty in the way of understanding their real structure and action arises from the awkward perspective in which we usually see them. It is but rarely that we can look straight down upon them so as to see their ground plan at one glance. Ordinarily, we see an imperfect sectional view, as if we saw a perpendicular slice of a house exhibiting in section the front set of rooms, and with imperfect glimpses of other rooms behind. We have also to do with objects so minute, and with parts so transparent, that only the most careful focussing and illumination, conjoined with much thought, can enable us even approximately to ascertain the exact superposition of different structures and the way in which they co-operate with each other. Mr. Huxley's paper on *Lacinularia socialis*, in the "Transactions of the Microscopical Society" for Dec. 1851, will give us valuable help in this matter. The trochal, or wheel-disk of the *Lacinularia* is, according to his description, "wide, and horse-shoe shaped. . . . The edge of the disk has a considerable thickness, and presents two always distinct margins, an upper and a lower, of which the former is thicker and extends beyond the latter. The large cilia are entirely confined to the upper margin and seated upon it; they form a continuous horse-shoe shaped band, which, upon the oral side, passes entirely above the mouth. The lower margin is smaller, and less defined than the upper, its cilia are fine and small, not more than one-fourth the size of those of the upper margin. On the oral side this lower band of cilia forms a V-shaped loop. About the middle of this margin, on each side, there is a small prominence, from which a lateral ciliated arch runs upwards into the buccal cavity, and below becomes lost in the

cilia of the pharynx. The aperture of the mouth, therefore, lies between the upper and lower ciliary bands." A simple set of wheel-cilia, always acting in the same way, would throw their whirlpool currents in one direction, but the addition of other cilia may readily enable the direction of the currents formed by the wheel-cilia to be changed, so as to suit the varying wants of the creature. The precise modes in which the wheel-cilia and the subordinate cilia are arranged vary considerably, but in every case in which I have been able to examine the ciliary apparatus under favourable circumstances, and with powers of from 600 or 700 to 1000 or 1500, I have found the quantity of cilia much larger than lower powers indicated, and the functions of the cilia, or of some of them, more varied than is commonly described. In examining a tube-dwelling species last year—the *Œcistes*, which Mr. Davis brought before the Royal Microscopical Society, with Beck's one-twentieth object-glass and powers of from about 900 to 1500—the wheel-cilia appeared as dense tufts, and many cilia were noticed in a position to assist in directing the chief currents, and which were not concerned in producing them. This creature repeatedly bent its head on one side, and, if I may use such a phrase, "licked" the matter adhering to a thread of conferva, with long cilia, apparently belonging to the wreath or to one of its rows. This licking action sometimes went on simultaneously with the rotatory movement.

Placing a single *Conochilus* under a compressorium, and viewing it with a power of 1000, an inner row of cilia was seen to be engaged in conveying particles down the buccal canal.

In the common rotifer, when the creature is extended and its wheel organs retracted, it is common to see a few cilia moving about its mouth. It can alter the form of its anterior extremity to a considerable extent, and appears to have full control of the cilia it occasionally throws out.

With respect to the cause of ciliary movement, nothing positive is known, but some cilia appears to be always in motion, while others belong to a voluntary or quasi-voluntary system. The wheel appearance results from the rythmical motion of various cilia moving in succession. When the movements are not too fast, and a sufficiently high power is displayed, it appears that each cilium is thrown into progressing and retreating curves, just as a long thin wand of whalebone may be thrown into wave motions by the wrist. When a breeze moves over a field of corn the aspect of advancing or retreating waves is produced by the alternate bendings and straightenings of the corn stalks, and a somewhat similar set of movements progressing round a ring, gives rise to the appearance of rotation so strikingly shown by the common rotifer and its allies.

The transition from strongly vibratory cilia to the more quiescent cilia belonging to the *Floscularia* and *Stephanoceros* seems abrupt, if we turn immediately from active wheel-cilia to the latter forms, but an attentive examination of rotifiers will often reveal cilia acting so gently as to bridge over the difference of the two kinds, and probably if the long quiescent cilia were strongly agitated by any force applied to their proximate extremity, that is, to the end which is inserted in the animal, they might execute the wave motions of the other sort. The particles composing wheel-cilia must be in a state of strong tension, and this would seem to result, not from a mere mechanical arrangement, as in a piece of whalebone or a steel spring, but from a cause which ceases with the life of the creature. As soon as a *Conochilus*, for example, is dead, its ciliary wreath falls together, in a comparatively soft-looking and inert mass. On the other hand, cilia less distinctively associated with voluntary motion continue their action when torn away from the organism of which they formed a part.

After the wheel-organs of rotifers, their so-called "gizzards" are their most striking features. These remarkable structures were very imperfectly known until Mr. Gosse communicated to the Royal Society his admirable papers on the subject. Mr. Gosse employed a solution of caustic potash to dissolve—which it does instantly—the soft flesh of the rotifers, and then was able to obtain the manducatory apparatus or gizzard in a separate form. By managing the screws of his compressorium so as to create water currents, he caused those organs to revolve in various directions, and with wonderful patience and skill made out details of structure and principles of action which had escaped previous observers. Mr. Gosse regards the gizzard as a *true mouth*, and he calls the muscular bulb containing the biting and grinding machinery a *mastax*. In *Brachionus urceolaris* and some of the *Hydatina* he finds the ap-

FIGS. 1, 2, and 3.—Mastax of Brachionus urceolaris (Gosse).

FIG. 4.—Mastax of Notommata clavulata (Gosse).

paratus most highly developed, and we may select a *Brachion* as our leading example. The preceding figure (1) of the mastax of *Brachionus urceolaris*, is copied from Mr. Gosse, and it will be more easily understood if we placed near it another sketch, Fig. 4, copied from the same writer, of the gizzard of the *Notommata clavulata*.

In the *Brachion mastax* we see two, to use Mr. Gosse's words, "geniculate organs," *b*, which he likens to hammers working on an anvil, and names *mallei*, and a third, *f*, still more complex, the *incus* (an anvil). These three pieces are not arranged in the same plane: for the *mallei* approach each other a little dorsally, while the incus is placed on the ventral side of the centre, its stem pointing considerably towards the same side. . . . Each malleus consists of two principal portions articulated with each other by a powerful joint, which seems to be ginglymate in its character, admitting of motion in one plane only, . . . the inferior portion of the malleus, which I call the manubrium (handle), *c*, is an irregularly curved piece, shaped somewhat like the scapula of a mammal, knotted on its broad and flattened at its lower or fine end, where also it is twisted on one side, ridges run down it on both the exterior and interior surfaces, the head is obliquely truncate, and it is this oblique surface, *d*, that is joined to the superior portion, *e*, which, from its prevalent form in the other genera, rather than in this, I call the *uncus* (hook). . . . It consists of five or six finger-like processes (Figs. 2 and 3), set parallel to each other, and separated by narrow interspaces, which appear to be occupied by a thin membrane. . . . The incus, *f*, consists of distinct articulated portions. The principal are two stout *rami*, *g*, resting on what appears to be a slender pedicel (*fulcrum b*), but viewed laterally, the *fulcrum* is seen to be a thin plate to the edge of which the rami are jointed, so that they open and shut like a pair of shears. Each *ramus* is a thick somewhat trigonal piece with the outer side rounded, the upper side hollowed, and the inner side flat, and in contact with the corresponding face of its fellow, in a state of repose. The *uncus* of each *malleus* falls respectively into the concavity of *each ramus*, and is fastened to it by a stout triangular muscle." The two *unci* alternately recede and approach, and at the same time the motion is complicated by a twist of the *manubria*. "The incus also has considerable motion, sometimes the *fulcrum* is elevated, and the *rami* depressed, so that the former is invisible; the *rami* open and shut with the working of the *mallei*, being fastened to them by the strong triangular muscle above mentioned. . . . It is also evident that they have a motion of separating and closing independent of the *mallei*, though this is comparatively limited in extent, and not very often exercised. Again, when substances are brought into

contact with the jaws, which for any reason are not acceptable, they are thrown up through the buccal funnel by a peculiar scoop-like action of the *unci*, which is very curious to witness."

A simplification of this description will obviously apply to *Notommata clavulata*, and to the jaws of the *Asplanchna Brightwellii*, shown in the plate; but it should be remarked that Mr. Gosse shows how strongly the jaws of the *Asplanchna* resemble the *incus* portion of the more complicated jaws of *Synchæta tremula* and *Diglena forcipata*, the *mallei* in *Asplanchna* being scarcely visible, and possessing no important function. Mr. Gosse's paper must be consulted to understand how the various parts are modified, or become obsolete in different genera; but it is advisable here to cite his popular explanation of the state of the organ in the common rotifer. He says, "Suppose an apple to be divided longitudinally, having the stalk attached to one half. Let this now be split longitudinally, so far as the stalk, but not actually separating any portion from it. Draw the two portions apart, and lay them down on their rounded surfaces. They now represent the quadrantic masses [composed of soldering together the *mallei* and *incus*], the stalk being the fulcrum, and the upper surfaces being crossed by the teeth. By the contraction of the muscles of which they are composed, the two segments are made to turn on their long axes until the points of the teeth are brought into contact, and the toothed surfaces rise and approach each other."

In the *Floscules*, Mr. Gosse finds the *mastax*, or bulb, wanting, "the dental apparatus, which is very small, springing from the paries (wall) of the stomach just below the second diaphragm."

The preceding quotations will serve as an introduction to the study of this, the so-called gizzard of rotifers; but it is important to state in connection with Mr. Gosse's opinion, that these organs are *jaws*, that he has witnessed their protrusion in *Furcularia, Pleurotrocha, Taphrocampa, Notommata clavulata, N. aurita, N. petromyzon, N. parasitica, Plagiognatha, Scaridium, Synchæta, Polyarthra, Diglena, Asplanchna, Mastigocerca, Monocerca, Salpina, Monostyla*, and *Anuræa*. As some of these are common species, Mr. Gosse's statements are easily verified by any student.

The stomachs and intestines of rotifers are richly ciliated, and near the stomachs may usually be seen bodies of considerable size, which appear to be organs secreting some fluid necessary to the process of digestion. In *Asplanchna*, the very curious circumstance occurs of a creature so highly organized being destitute of an intestine, or an anal orifice. The undigested portions of its food being cast out through the gullet and

mouth. In this genus great voracity is exhibited, as may be imagined, from the quantity of other rotifers and objects of various kinds often seen in the stomach at the same time. The body of the *Asplanchna* and its integuments are very transparent, and the stomach usually yellow or brown, so that the little creatures are easily seen in a bottleful of water lucky enough to contain them. They afford excellent illustrations of ciliary stomach-currents. The whole stomach appears lined with cilia, and they produce, by a somewhat violent action, remarkable whirlpools amongst the particles of food. *Conochilus* will show the same thing in a less striking way. It is not so voracious, the cilia are more delicate, and the stomach not so filled with hard matters capable of turning the currents out of their path. Powers of at least 600 or 700 are necessary to see these phenomena well, and they require careful illumination. The ciliary currents in the stomach in *Asplanchna* are shown in the plate. The stomach-currents are plain in many of the *Brachions*, and their existence may be demonstrated with powers of about 200 to 250.

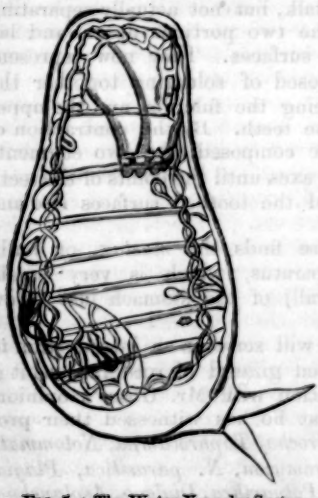


Fig. 5.—The Water Vascular System of Notommata aurita, showing the twisted tubes, vibratile tags, and contractile vesicle. Reduced from drawing by Mr. Gosse. Viscera omitted.

From the digestive apparatus we may proceed to the water-vascular system, which is probably, as before stated, respiratory and excretory. It consists of delicate bands or tubes, to which, in most cases, "vibrating tags" are attached. This system of apparatus is connected with the contractile vesicle, popularly called a "heart," though no physiologist now considers it to be an organ of blood circulation. The annexed diagram shows the water-vascular system of *Notommata aurita*, as represented by Mr. Gosse ("Trans. Mic. Soc.," 1850). The stomach and other organs are not shown in this drawing. In *Asplanchna* I have noticed the tags, as shown in the accompanying plate, Fig. 5. They were ciliated at their ends, and exhibited a flickering motion in the direction of the dark line; and this was probably occasioned by an internal cilium like that which Prof. Huxley describes in *Lacinularia*.

I can only very briefly advert to the reproductive apparatus of rotifers. It has already been mentioned that the males of those species in which they have been discovered (about thirteen or fourteen) have but a brief existence. Mr. Gosse —to whom we owe most of our knowledge of them—could never preserve one alive for more than twenty-four hours. They are unlike the females in appearance, as well as in the absence of digestive organs, and they contain patches of opaque matter, which is white by *reflected*, and black by *transmitted* light. Mr. Gosse was so fortunate as to see one emerge from an egg of *Brachionus pala*, and was struck with its differing from the ordinary offspring of that creature.

The ovary of the female rotifer is remarkably conspicuous and of peculiar shape in *Asplanchna*, looking like a long cushion, bent in a more or less horse-shoe form. In the Plate, Fig. 1, the ovary is shown, and Fig. 3 is a portion of it magnified 1000 times linear, showing the germinal vesicles from which the eggs arise. In *Asplanchna* the internal apparatus has plenty of room, and is extremely moveable. When everything is in its usual position, the large stomach is seen hanging to the gullet, while the ovary bends like a horse-shoe, and partially surrounds it.

The nervous system of rotifers is probably simple, but as yet imperfectly made out. In *Brachionus* a large cerebral ganglion is seen easily behind the beautiful red eye; and in *Lacinularia*, Prof. Huxley describes a "bilobed homogeneous mass, resembling in appearance the ganglion of *Brachionus*, and running into prolongations below; but whether continued into cords or not he could not make out."

Many rotifers exhibit some symptoms of intelligence, as when the common rotifer goes groping about, or the tube-dwellers incline their heads towards particular objects. The *Metopidia acuminata* has a curved organ like half a pickaxe attached to its head, and works about with this, raking amongst rubbish, and selecting what it requires, somewhat like a French *chiffonier* with his hooked stick. If a number of *Brachions* are put in a vessel they soon come near each other, perhaps deriving some pleasure or advantage from the action of each other's whirlpools; but we must beware lest we ascribe too much *purpose* to movements which may be the involuntary results of circumstances, and it is curious that Mr. Gosse observed a *Melicerta* making and depositing her pellets, when her tube was broken, and she could place none where they could be of use.

The localities in which rotifers are found are chiefly in fresh and salt water, though some can live in damp moss. Some attach themselves to plants, others swim freely, and others lurk in sedimentary deposits. I have found the

common rotifer in a slime which forms on the cotton thread of a Mason's Hygrometer, where the supply of food must have been exceedingly small. They get into the cells of certain mosses, into the tubes of confervæ, and Mr. Gosse described in "Mic. Trans., 1850," a form of *Notommata* (*parasitica*), inhabiting the sphere of *Volvox globator*.

The rank to be assigned to rotifers, or rather their place in the animal series, has been warmly discussed—most physiologists coinciding with von Siebold and Huxley, by whom they are associated with the *worms*, or rather with that portion which Mr. Huxley designates *Annuloida*. He says, "the terms of resemblance are these:—(1.) Bands of cilia resembling and performing the functions of the wheel organs are found in *Annelid*, *Echinoderm*, and *Trematode* larvæ. (2.) A water-vascular system essentially similar to that of the rotifers is found in *Monœcious Annelids*, in *Trematodes*, in *Turbellaria*, in *Echinoderm*, and perhaps in the *Nematoidea*. (3.) A similar construction of the nervous system is found in *Turbellaria*. A somewhat similarly armed gizzard is found in the *Nemertidæ*, and the pharyngeal armature of a *Nereid* larva may well be compared with that of *Albertia*. (5.) The intestine undergoes corresponding flexures in the *Echinoderm* larvæ. There are, therefore, no points of their organization in which the rotifer differs from the *Annuloida*."

It is an interesting question whether any of the rotifers possess *true-jointed limbs*. Mr. Gosse says of *Dinocharis*—"This genus is remarkable for possessing true joints in the foot; not merely telescopic inversions of the skin, but permanent articulations with swollen condyles resembling those of the antennæ of a beetle. This fact helps to indicate that this class of animals has its proper affinities with the Articulata, which has been denied by most naturalists."

Should, which seems probable, the rotifers retain the place assigned to them by Siebold and Huxley, their relations with other groups as pointed out by Mr. Gosse are nevertheless very likely to be strengthened by further investigation.

DESCRIPTION OF PLATE.

1. Side view of *Asplanchna Brightwelli*, showing stomach with two egg-shaped glands, the ovary and large resting-egg, magnified 80.
2. The jaws, magnified 240.
3. Portion of ovary, magnified 100.
4. Stomach currents, magnified 1000.
5. Portion of water-vascular system with tags: the dark lines down the tags represent internal ciliary action, magnified about 1000.

STANDARDS OF WEIGHTS, MEASURES, AND COINAGE.

BY JOSEPH NEWTON.

LAST year saw carried into effect certain recommendations in reference to the above-named subject, which had been earnestly made and frequently reiterated many years previously. By virtue of an Act of Parliament, which received the Royal assent, on the 6th of August, 1866, the custody of the Imperial standards of length and of weight, together with all secondary standards of weights and measures, all balances, apparatus, books, documents, and things relating thereto, and of the Trial-plates for testing the purity of the coin of the realm, was transferred from the office of the Exchequer to the Board of Trade. The change of arrangement thus ordered to be made was in all respects a remarkable one, for it disturbed a system which had existed from the days of William the Conqueror, when the Exchequer Court formed part of the well-known Aula Regia.

The actual transfer of the custody of the standards, etc., and the determination of his powers and duties connected with them were reported by the Comptroller-General of the Exchequer on the 31st August, 1866, to the Treasury. The same communication made reference, also, to the speedy transfer of the coinage trial-plates to the Board of Trade. Thus the Exchequer was quietly denuded of important duties associated with it from a remote period of English history, whilst a great amount of extra responsibility was imposed upon its more modern and, it must be added, more active successor, the Board of Trade. It would be interesting to trace the annals of the Court of Exchequer from its origin to its partial demise, but it is no part of our present purpose to do so.* We have no intention either to say one word in disparagement of the venerable institution, or of those who filled offices in it. It is, nevertheless true that for many years past the Court of Exchequer, which had charge and care of the national standards of length, weights, and measures, paid no attention whatever to their exactitude. The legislature, and not the Exchequer, must be held accountable for the neglect, for in reality there existed, up to last year, no legal authority whatever for verifying the standards. They had remained, therefore, exactly

* Those who wish to obtain authentic and quaint information of the early history of the Exchequer are referred to the "Dialogus Scaccrario," written by Richard Fitz-Nigel, Treasurer to King Henry II., and printed at the end of Madox's "History of the Exchequer."

as they were constructed in 1824, plus certain alterations made in them by climatic influences, and the hand of time. Oxidation and other deteriorating powers were, of course, not idle, and the standards suffered accordingly. It was nobody's business to attend to their periodical verification, and nobody did attend to it. Hence, the fountains of justice, as it were, became tainted at the source, the so-called standards were no standards at all, and the primary instruments upon which depended (by comparison) the accuracy of all subsidiary weights and measures of the United Kingdom were false guides—blind leaders of the blind. Even in 1853, when new theoretical standards of weights and of length were legalized and promulgated, no comparisons of the old material standards were instituted.* It may seem passing strange that such an omission should have been permitted, but it is for us at present simply to record it as a fact, without further comment.

From these premises it will be readily conceded that the reformatory movement of last year was not made one moment too soon, and, doubtlessly, the interests of the public will be largely promoted by it. There now exists in connection with the Board of Trade, and, of course, subordinate to it, a distinct branch, known as the Standards Department, with an efficient staff of officers, and all necessary appliances, for the express purpose of verifying and maintaining in exact order the imperial standards, primary and secondary, of Great Britain and Ireland. To ensure and facilitate the comparison and verification of provincial, colonial, and local, with and by aid of the master standards, the abolition of all fees and of the stamp-duty payable hitherto for the operations, has been decreed. At the head of the new department, the office of which is in Old Palace Yard, Westminster, is Mr. H. W. Chisholm, whose title—a very appropriate one—is that of Warden of the Standards. Under his energetic and practical guidance it is tolerably certain that the important duties of the whole department will be zealously and efficiently performed, and that the standards will shortly be in as perfect a condition as such arbiters should be in the first commercial nation of the world.

In fact, the Warden has, during his first year of office, just closed, evinced a considerable amount of activity, and caused thereby many valuable improvements as compared with the compulsory "let-it-alone" system of the Exchequer. His

* A perfect standard is only found in nature, and is, therefore, immutable; but a *measure* is variable at the will and pleasure of man. In France, a standard of length is found in the 400,000,000th part of the earth's circumference, which is equal to 39,370 English inches, and is known as a metre. In England, the philosophical standard of length is a pendulum, vibrating seconds in the latitude of Greenwich, and this is, by a law of nature, invariable. From this standard comes the yard and all other measures of length.

searching inquiries have led to the elicitation of some rather startling revelations. For example, it has been discovered that out of three hundred and one cities and towns in Great Britain, which have in times past been furnished with so-called authoritative and judicial standards, one hundred and twenty have now only illegal ones. This amounts to thirty-six per cent. of the whole number. Out of fifty-seven manors or liberties similarly supplied with official arbiters of weights and measures, not less than forty-four, or seventy-seven per cent. (of said standards) have been condemned as quite unreliable. It is feared that further examinations will lead to the elimination of further discrepancies; and in Ireland it is known that the proportion of defective standards is very large. The consequences of these circumstances to the community at large, are very serious. The conviction of dishonest traders in any locality where illegal standards exist, is an impossibility. The Weights and Measures' laws are in such cases "dead letters," for they distinctly specify that the standards shall be legal by which comparisons are to be made.

The significance of these statements is augmented in presence of the known increase of the species of fraud just indicated, namely, the giving of short weights and measures among shopkeepers and others. It is of the highest moment that local standards should be periodically adjusted and reverified, so that thereby the majesty of the laws of England shall be upheld.

From a consideration of the foregoing statements, it is hoped that a clear conception of the importance of the task of the verification of the standards of length, weight, and capacity,* will be gained. Of the value or otherwise of the standard trial-plates for testing the purity of coins, a word or two shall be said hereafter.

In view of the momentous issues involved in the re-adjustment of the standards, the Government has nominated a commission to assist the warden in the performance of the work. That commission is composed of the following gentlemen—the Earl of Rosse, Lord Wriothesly, Sir John Shaw Lefevre, Lieutenant-General Sabine, the Astronomer-Royal, the Master of the Mint, and Professor W. H. Miller. The labours of this eminently scientific body are to be confined mainly to an inquiry into the condition of the old Exchequer Standards, and to ascertain in how far these agree with the Imperial Stand-

* It may be stated that the standards of weight and capacity are based upon principles coincident with those which govern the standard of length, namely, the laws of Nature, while their corresponding measures are mere artificial arrangements. The thermometer illustrates these distinctions very well. The boiling and freezing points of water constitute standards of heat; the intermediate gradations are measures of it.

ards, and with each other. They are also to report from time to time the results of their examinations and experiments, and to recommend such further changes, modifications, and renewals of standards as they may see fit. In short, the Commissioners have undertaken an exhaustive inquiry into the whole subject, of a most minutely scientific character. Up to the present time, we believe, the preliminary official comparisons of the Standards of Avoirdupois and Troy weights only have been effected. The errors in regard to the Avoirdupois Standards, are found to be the greater of the two, and this arises from the fact of their having been much more frequently used. It is only by innumerable weighings, testings, calculations, and comparisons, that anything like absolute truth can be arrived at. The changes of temperature in our variable climate affect not only the dimensions, but the weight of all metallic bodies. A sovereign, for example, held for a minute between the finger and thumb, expands in size and increases in weight. It imbibes heat and has moisture imparted to its surface. Hence the changes. The same principle affects, more or less, all simple or compound metallic substances. It is a point, therefore, in the construction of standards, to employ such admixtures of metal as are least influenced by atmospheric variations.

The Standard Commission, it is understood, are about to institute comparisons of the remaining official standards of "bullion-weight, capacity, length, and gas measures of volume," as well as to the re-verification of the standard of length—the yard. This latter will be effected by a new micrometrical comparing apparatus of great delicacy. The apparatus is to be adapted for longer measures than the yard, as well as to its subdivisions. A totally new standard bar of greater length than the yard, is indeed, in course of preparation, and this will answer a double purpose. Upon it will be indicated not only the yard, with its subdivisions into feet and inches, and the minute subdivisions of the latter, but the French metre with its subdivisions also. This is the more essential, since in very many of the mechanical and engineering establishments of the kingdom, the metrical system of measurement is constantly employed; and the probability being that in time the plan will be widely extended.

In reference to the verification of measures of capacity, the authorities of the Standards' Department have adopted an elaborate mode originally suggested by Captain Kater. Its main feature consists in weighing the exact contents of each measure —those contents being distilled water. In order to accomplish this effectually, accurate observations of the pressure and the temperature of the atmosphere have simultaneously to be

taken. The furnishing of the department with the most perfect apparatus and scientific appliances which it is possible to obtain is very properly insisted upon by the warden, for without these and their most scrupulously careful use errors would be generated and multiplied.

It has been suggested as points of importance for the consideration of the Standards' Commission:—1st. The proposed addition to the present number of official standards, and, consequently, to the number of weights and measures in common use, and which may involve the serious question of the establishment or the continued prohibition of metric standards, and weights, and measures in this country.* 2nd. The question of extending the powers and functions of the Standards' Department in relation to the duties performed by the numerous local inspectors of weights and measures throughout the kingdom.

As regards the first of these points, it is to be desired that the commission *will* give it consideration, and should their deliberations result in a recommendation in favour of the establishment of metric standards and weights throughout Great Britain and Ireland, so much the better. Less importance attaches itself to the custody of the standard trial-pieces of gold and silver, used for determining the justness of the gold and silver coins of the realm issued from the Royal Mint, than to that of the imperial standards of length, weight, and capacity. The INTELLECTUAL OBSERVER† has demonstrated the utter inutility of such a mode of determining the purity of gold and silver coins as the standard trial-pieces furnish. When these latter were transferred from the custody of the Exchequer Court, their proper destination was the Royal Mint, and its crucibles. Perhaps they may yet reach that destination.

* As an instance of the confusion which now obtains as to the legality or otherwise of metric weights and measures, the following is adduced. One of the inspectors of weights and measures for the county of Surrey seized some metric weights in a tradesman's shop in Southwark last year. On his bringing the matter before the magistrates, the defendants alleged that the Metric Act, 1864, 27 and 28 Vict. c. 117, permitted the use of metric weights, but gave no power to the inspector to examine them. The magistrate dismissed the summons, observing that the Act was loosely drawn, and that the defendants were justified in using metric weights. The Board of Trade consulted the law officers on this case, and they decided that, notwithstanding the provisions of the Metric Act, a person *using* metric weights or measures is liable to have them seized and forfeited under the Act 5 and 6 Will. IV. c. 63.

† *Vide* No. lxi., p. 10, February, 1867.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1867. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
July 1	29·796	71·1	59·2	·68	·753	80·4	53·0	27·4	3, 7, 4	S by W, SE, SW.	0·000
„ 2	30·685	59·7	57·6	·93	·518	68·2	56·7	11·5	10, 9, 6	S, WSW, W by N.	·257
„ 3	29·999	59·8	53·4	·81	·519	71·0	54·9	16·1	10, 10, 8	S, W by S, SW.	·009
„ 4	29·855	61·0	57·8	·90	·541	70·8	54·9	15·9	10, 9, 4	S by W, S, SW by S.	·146
„ 5	30·055	59·2	47·7	·68	·509	67·5	57·5	10·0	7, 8, 8	WNW, WNW, NNW.	·006
„ 6	30·157	59·6	46·7	·65	·516	70·8	45·7	25·1	6, 8, 8	WNW, NW, NW by W.	·000
„ 7	...	...	...	...	...	69·0	49·5	19·5	...	... ...	·000
„ 8	30·267	60·0	48·6	·68	·523	70·1	47·0	23·1	0, 3, 3	—, ENE, NE.	·000
„ 9	30·253	62·4	51·4	·69	·566	70·8	46·1	24·7	3, 8, 10	NE, NE, N.	·000
„ 10	30·189	63·8	51·0	·65	·593	74·4	48·3	26·1	10, 1, 2	N by W, NE by N, SE.	·000
„ 11	30·076	64·5	52·7	·67	·607	73·8	46·4	27·4	2, 2, 4	SE, E, E.	·000
„ 12	29·812	64·0	50·4	·63	·597	73·0	55·1	17·9	7, 10, 7	E, E by N, E by N.	·000
„ 13	29·732	58·9	57·4	·95	·504	69·6	53·6	16·0	10, 10, 10	SW by S, S by W, SW by S.	·000
„ 14	...	...	...	...	...	70·1	54·5	15·6	...	... ...	·334
„ 15	29·499	57·0	52·8	·87	·473	64·9	52·7	12·2	10, 9, 8	S by W, S by W, SSW.	·120
„ 16	29·512	55·9	53·0	·90	·456	65·8	55·0	10·8	6, 9, 7	SW, S by W, SW by S.	·241
„ 17	29·708	59·5	45·4	·62	·514	68·6	53·1	15·5	4, 8, 8	WSW, W by S, WNW.	·228
„ 18	29·591	58·3	52·6	·82	·494	68·7	55·6	13·1	10, 7, 8	SW by W, WSW, S by W.	·381
„ 19	29·681	57·6	51·2	·80	·483	64·9	51·6	13·3	7, 9, 10	W, W, NW by W.	·047
„ 20	29·806	57·8	56·3	·94	·486	69·8	52·0	17·8	5, 9, 9	WSW, SW, SW.	·003
„ 21	...	...	...	...	...	70·1	57·6	12·5	...	... ...	·094
„ 22	29·694	61·8	54·0	·77	·555	72·2	54·5	17·7	10, 4, 9	E, SW, SW by S.	·010
„ 23	29·615	61·2	53·3	·77	·544	70·1	55·3	14·8	7, 6, 4	SW by S, SW by S, SW.	·224
„ 24	29·703	58·9	46·0	·64	·504	68·8	51·7	17·1	6, 8, 9	SW by W, W, SW by W.	·020
„ 25	29·771	60·1	50·5	·72	·525	70·7	44·1	26·6	4, 8, 10	SE, ESE, E by S.	·000
„ 26	29·626	50·6	...	...	·381	57·7	51·9	5·8	10, 10, 10	NNE, N, NNE.	1·328
„ 27	30·026	51·4	44·0	·78	·391	59·8	48·8	11·0	10, 10, 10	NW, NNW, N by W.	·158
„ 28	...	...	...	...	...	66·1	45·1	21·0	...	... ...	·000
„ 29	30·042	57·2	44·3	·64	·476	66·2	45·3	20·9	5, 4, 2	N, NW, N.	·000
„ 30	30·020	57·1	45·9	·68	·475	66·8	44·9	21·9	3, 4, 9	NW by N, NW by W, NNW.	·000
„ 31	29·984	60·1	49·0	·69	·525	68·6	47·4	21·2	2, 9, 9	—, E by N, SSE.	·000
Daily Means.	29·894	59·6	51·2	·75	·519	...	...	17·7	...	... ...	3·606

* To obtain the Barometric pressure at the sea-level, these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JULY 1867.

	Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
	Hour.																																
	12																																
A.M.	1	5	3	10	10	3	4	1	1	2	1	4	7	4	7	7		15	10	11	7	14	7	15	2	4	12	7	5	4	1	1	6·1
A.M.	2	4	3	5	12	4	5	4	2	1	0	4	7	4	8	8		15	5	12	9	11	4	7	3	6	10	6	3	2	1	2	5·6
A.M.	3	1	1	5	12	6	3	5	1	1	1	1	8	3	5	9		17	6	10	6	7	4	1	4	2	13	7	1	4	3	1	4·9
A.M.	4	3	1	5	11	5	4	2	2	0	0	1	5	2	7	13		17	6	11	5	9	9	5	3	1	15	9	4	4	3	0	5·4
A.M.	5	6	7	6	10	3	3	4	1	1	2	1	5	3	2	15		15	10	11	10	10	7	5	3	1	17	8	3	3	5	1	5·9
A.M.	6	1	7	3	10	4	3	4	2	0	1	1	4	2	3	17	281	15	15	11	9	13	11	10	4	0	16	7	5	6	4	3	6·3
A.M.	7	3	1	5	11	7	4	3	4	1	1	5	8	3	8	20		19	14	15	9	13	13	14	6	3	19	7	3	4	4	2	7·6
A.M.	8	2	4	3	12	7	6	6	7	1	3	2	10	4	10	9		21	14	17	9	17	15	18	9	5	18	10	5	6	4	3	8·6
A.M.	9	3	5	3	14	10	8	6	4	4	2	7	9	3	9	19		20	17	19	10	16	15	19	10	5	19	12	10	9	7	4	9·9
A.M.	10	2	4	2	14	10	13	10	2	3	3	2	11	4	8	19		22	13	19	10	17	17	19	13	7	20	11	9	8	6	6	10·1
A.M.	11	3	5	2	15	11	13	9	3	4	3	10	13	4	22	18	23	23	16	18	10	20	18	19	13	6	23	11	10	13	9	4	12·0
A.M.	12	3	7	3	16	15	14	2	7	7	6	10	8	2	10	20	23	23	12	19	10	22	17	21	10	5	22	11	8	10	8	6	11·5
P.M.	1	3	6	3	15	15	14	10	6	6	6	12	10	4	23	22	21	24	17	15	10	18	21	25	13	5	25	13	9	12	6	7	12·8
P.M.	2	4	6	5	17	12	12	7	8	6	6	12	9	6	12	27	17	22	17	18	12	21	25	25	13	5	22	10	11	10	8	6	12·6
P.M.	3	7	10	6	13	16	10	9	11	6	5	12	12	7	19	24	13	21	19	17	14	19	27	25	12	7	25	8	10	9	6	10	13·2
P.M.	4	13	10	16	13	12	10	7	11	7	7	15	12	3	15	29	19	19	20	18	20	20	27	25	11	8	23	9	17	10	6	10	14·1
P.M.	5	12	10	17	11	14	17	9	12	6	9	17	16	3	18	30	18	23	15	17	14	20	25	23	11	8	24	8	13	10	7	9	14·4
P.M.	6	15	14	15	8	11	9	5	12	6	9	12	21	4	17	30	16	21	7	15	17	18	20	20	10	8	21	3	9	7	3	1	12·4
P.M.	7	11	12	13	5	11	7	6	10	10	9	13	20	5	13	30	14	19	11	15	13	13	18	17	8	12	22	3	6	5	2	2	11·4
P.M.	8	7	9	10	4	6	7	7	10	10	9	14	14	2	13	26	13	16	14	11	11	14	13	12	7	10	20	2	4	3	1	2	9·7
P.M.	9	4	9	9	6	4	6	7	6	4	9	18	3	3	17	24	11	14	11	9	11	10	8	8	5	10	15	2	3	4	0	5	8·2
P.M.	10	4	6	7	8	4	5	5	7	3	6	15	12	5	8	25	10	15	7	8	12	12	6	7	5	10	9	3	3	7	1	5	7·7
P.M.	11	1	8	9	5	1	4	3	5	3	3	14	7	5	5	27	14	13	11	10	15	8	10	6	6	12	10	3	2	3	4	4	7·4
	12	7	7	10	3	1	1	1	2	1	1	12	5	8	5	29	14	10	7	6	16	8	15	5	4	11	7	3	3	3	2	2	6·7
	Total Daily Movement.	121	155	172	255	192	182	122	136	93	102	214	236	93	264	497	507	439	294	332	269	350	352	351	185	151	427	173	156	156	101	96	9·6

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		Rain—read at 9·30 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Aug. 1	29·983	52·3	45·7	·80	·404	58·7	49·2	9·5	10, 10, 10	NE, NE by E, NE.	0·000
„ 2	30·014	49·3	45·2	·87	·364	58·5	48·9	9·6	10, 10, 10	N by E, NE by E, NNE.	·000
„ 3	30·051	57·9	45·6	·66	·487	67·9	42·3	25·6	8, 6, 6	—, N, NE.	·000
„ 4	...	...	...	...	...	69·5	51·4	18·1	...	...	·000
„ 5	29·983	60·7	51·7	·74	·535	70·2	49·6	20·6	4, 9, 9	WSW, W by S, S by W.	·000
„ 6	29·753	55·2	54·4	·97	·445	64·4	56·3	8·1	10, 10, 7	SW, SSW, W by S.	—
„ 7	29·753	55·8	53·6	·93	·454	64·7	47·9	16·8	10, 9, 10	SW, SW by S, SW by S.	·306
„ 8	29·719	63·3	51·7	·68	·583	71·5	54·8	16·7	9, 6, 7	SW by W, WSW, W by S.	·320
„ 9	29·846	62·5	51·3	·69	·568	70·0	57·7	12·3	5, 8, 5	WSW, WSW, W.	·060
„ 10	30·110	62·7	53·0	·72	·572	72·7	48·8	23·9	4, 5, 5	NW, SW, WSW.	·000
„ 11	...	...	...	...	...	76·1	48·4	27·7	...	...	·000
„ 12	30·075	74·0	59·0	·61	·827	81·0	57·8	23·2	4, 1, 0	S by W, S, SE.	·000
„ 13	30·003	75·4	58·6	·58	·865	83·2	57·4	25·8	0, 0, 0	E, ESE, E by S.	·000
„ 14	29·915	77·0	66·4	·71	·910	85·9	59·1	26·8	3, 0, 0	S by W, S by E, S by E.	·000
„ 15	29·700	58·1	...	...	·491	64·9	61·5	3·4	9, 10, 10	WSW, S by W, S by E.	·180
„ 16	29·748	60·7	50·7	·71	·535	69·7	55·3	14·4	7, 7, 7	W by N, W, W by S.	·211
„ 17	29·890	61·9	57·0	·85	·557	70·0	53·7	16·3	10, 9, 2	SW by S, SW, SW,	·000
„ 18	...	...	...	...	...	73·0	59·9	13·1	...	...	·000
„ 19	30·010	58·9	...	...	·504	77·3	57·3	20·0	0, 4, 0	—, SW by S, SSE.	·000
„ 20	29·878	64·3	55·2	·74	·603	71·2	63·0	8·2	10, 7, 3	SW, S by W, SW by S.	·830
„ 21	30·004	61·8	52·0	·72	·555	70·7	53·8	16·9	7, 9, 6	W by S, W, —.	·000
„ 22	30·020	63·5	51·7	·67	·587	73·1	49·3	23·8	0, 2, 2	W by S, —, SW.	·000
„ 23	30·031	66·2	53·2	·65	·642	74·9	48·0	26·9	2, 1, 2	SW by S, W by N, SSW.	·000
„ 24	30·062	65·8	59·8	·82	·633	74·0	49·7	24·3	8, 2, 1	SSW, SW, SW by S	·000
„ 25	...	...	...	...	...	75·0	55·5	19·5	...	...	·000
„ 26	29·965	56·1	55·9	·99	·459	69·3	57·0	12·3	10, 10, 10	SW by S, —, —.	·000
„ 27	30·042	59·3	46·8	·65	·511	68·3	48·0	20·3	7, —, 3	SW, W, W by N.	·145
„ 28	30·159	58·4	53·8	·86	·496	67·8	45·1	22·7	9, 10, 10	SW, SW by S, SW by S.	·000
„ 29	30·165	63·3	61·4	·94	·583	70·9	57·5	13·4	10, 10, 10	SW, SW, SW.	·000
„ 30	30·038	62·3	54·6	·78	·564	72·7	55·3	17·4	10, 7, 4	SW by W, SW by W, SSW.	·005
„ 31	29·843	68·4	57·3	·69	·690	75·7	55·8	19·9	3, 2, 7	E by S, E by N, E by N.	·000
Daily Means.	29·584	62·0	53·8	·76	·751	...	...	18·0	...	... ...	2·057

* To obtain the Barometric pressure at the sea-level, these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—AUGUST, 1867.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12 1	2	14	1	2	2	11	7	12	12	6	2	1	8	4	1	5	9	14	4	5	9	3	1	1	5	6	4	4	2	8	10	5·7
1 2	5	10	1	3	4	10	9	13	6	4	1	4	6	3	3	10	11	15	3	10	7	3	0	0	4	3	3	3	3	6	6	5·9
2 3	7	6	1	4	3	9	4	8	4	1	1	3	4	2	2	6	6	11	4	10	5	4	1	2	4	2	2	2	4	4	4	5·1
3 4	9	12	2	3	3	13	9	12	6	1	1	5	5	3	1	7	9	13	5	12	9	4	1	3	6	3	4	3	5	3	4	5·7
4 5	12	13	2	4	3	11	6	10	4	0	1	5	6	3	2	6	10	14	6	13	10	5	2	4	7	4	4	2	6	5	5	5·2
5 6	10	14	3	3	3	11	5	10	4	0	1	5	6	3	2	6	10	18	7	14	11	5	2	4	7	5	5	3	6	4	3	5·1
6 7	8	12	3	3	3	10	3	9	5	0	1	5	6	3	2	6	10	18	11	14	11	5	2	4	7	5	5	3	6	3	3	5·9
7 8	11	13	4	3	3	9	2	8	6	0	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	6·8
8 9	12	14	4	2	3	8	2	8	7	0	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
9 10	13	14	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
10 11	13	14	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
11 12	13	14	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
P.M. 12 1	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
1 2	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
2 3	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
3 4	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
4 5	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
5 6	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
6 7	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
7 8	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
8 9	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
9 10	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
10 11	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
11 12	12	13	3	3	4	8	3	8	9	2	1	5	6	3	2	6	10	17	11	13	11	5	2	4	7	5	5	3	6	3	2	7·4
Total Daily Movement.	294	209	83	90	205	207	176	285	244	130	61	203	221	87	163	218	418	252	142	312	148	99	96	130	192	127	111	191	170	228	227	7·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867. Day of Month.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Sep. 1	...	...	...	...	...	75·7	59·4	16·3	...	...	0·003
„ 2	30·092	66·8	54·5	.66	·655	75·7	52·3	23·4	2, 3, 2	NE, E, E by S.	·000
„ 3	29·966	64·1	63·5	·98	.599	75·0	60·8	14·2	10, 9, 10	E, E, E.	·390
„ 4	29·820	62·6	56·1	·81	·570	70·0	58·0	12·0	10, 8, 1	SW by S, SW, SSW.	·052
„ 5	29·850	60·0	54·0	·82	·523	68·6	57·6	11·0	10, 4, 3	SW by S, S by W, SSW.	·148
„ 6	29·773	58·3	52·7	·83	·494	67·5	51·1	16·4	8, 7, 4	SW, SW by W, SSW.	·013
„ 7	29.955	60·3	50·7	·72	·528	69·3	54·3	15·0	4, 4, 8	SW by W, WSW, SW.	·000
„ 8	...	...	...	...	...	69·1	47·8	21·3	...	...	·000
„ 9	29·860	60·4	52·5	·77	·530	70·1	52·6	17·5	5, 7, 10	WSW, SW, SW.	·000
„ 10	29·885	58·6	48·9	·72	·499	67·0	52·4	14·6	4, 4, 9	WSW, SW by W, W by S.	1·010
„ 11	29·930	57·9	55·4	·92	·487	66·8	47·3	9·5	10, 10, 10	ESE, SSW, —.	·325
„ 12	29·795	62·2	55·3	·79	·563	70·5	58·2	12·3	6, 7, 6	SW by S, SW, SSW.	·000
„ 13	29·936	58·9	49·5	·73	·504	67·1	52·6	14·5	6, 9, 7	—, SW by W, SW.	·000
„ 14	30·011	56·8	50·3	·80	·469	64·5	47·8	16·7	5, 8, —	SW, WSW, —.	·000
„ 15	...	...	...	...	...	64·8	51·1	13·7	...	...	·076
„ 16	30·200	53·7	42·4	·68	·423	60·7	45·5	15·2	4, 6, 2	NNW, N by E, NE by N.	·015
„ 17	30·378	50·4	42·2	·75	·378	57·9	43·3	14·6	9, 9, 9	NNW, NNE, N.	·000
„ 18	30·296	56·0	47·9	·76	·457	63·7	49·7	14·0	6, 8, 8	N, NE by N, NNE.	·036
„ 19	30·136	57·0	51·1	·82	·473	65·6	51·0	14·6	8, 7, 3	NE by N, NNE, NE by E.	·000
„ 20	30·156	54·2	46·5	·77	·430	62·6	51·5	11·1	10, 4, 2	N, N, N by E.	·000
„ 21	30·124	52·5	45·3	·78	·406	61·6	45·5	16·1	9, 0, 2	—, SW by W, SW.	·000
„ 22	...	...	...	...	...	64·6	50·5	14·1	...	...	·160
„ 23	29·954	56·9	54·4	·92	·471	64·8	45·5	19·3	10, 9, 7	SW, SW, WSW.	·035
„ 24	30·188	51·6	39·1	·65	·394	59·8	47·3	12·5	7, 8, 5	NW by N, N, NNE.	·000
„ 25	30·455	51·1	44·9	·81	·387	59·3	35·5	13·8	4, 6, 4	NW, NNE, NNW.	·000
„ 26	30·435	51·4	47·0	·86	·391	61·9	38·9	23·0	0, 5, 7	— — —	·000
„ 27	30·324	52·8	45·2	·77	·410	60·6	46·6	14·0	9, 3, 8	W by S, SW by W, WSW.	·000
„ 28	30·226	55·6	48·0	·77	·451	62·4	49·3	13·1	3, 9, 7	W by S, SW by W, WSW.	·000
„ 29	...	...	...	...	...	61·7	49·3	12·4	...	...	·000
„ 30	30·035	52·5	48·7	·87	·406	63·1	50·3	12·8	1, 10, 10	W, W by S, WSW.	.000
Daily Means.	30·071	56·9	49·8	·79	·475	...	...	15·0	...	...	2·263

* To obtain the Barometric pressure at the sea-level, these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.

SEPTEMBER, 1867.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Hourly Means.
Hour.																										
A. M.	12	10	1	10	4	18	5	14	7	3	10	2	13	4	6	8	6	6	15	11	8	4	12	7	9	8·0
	1	5	1	20	2	16	4	15	6	1	15	3	16	4	5	9	5	7	15	12	8	3	12	7	9	8·3
	2	5	0	14	1	13	8	12	4	1	10	2	15	1	4	9	6	5	18	10	9	5	13	8	10	7·6
	3	5	1	15	1	9	7	16	1	1	9	1	11	2	5	9	6	7	17	11	10	3	13	4	9	7·2
	4	5	1	16	2	7	11	18	1	1	6	1	10	1	5	11	5	9	18	8	12	4	14	8	10	7·7
	5	4	1	10	9	5	11	16	1	1	7	1	12	1	7	11	7	8	18	8	10	3	15	10	10	7·7
	6	1	1	9	6	8	12	15	1	1	11	2	11	1	4	7	7	9	19	9	10	3	13	15	8	7·6
	7	2	1	12	11	8	16	22	5	8	10	1	9	3	10	13	8	11	22	9	13	5	14	16	14	10·1
	8	4	4	12	12	4	20	21	10	11	12	4	15	4	17	14	12	13	27	9	10	4	13	18	19	12·0
	9	8	5	13	12	7	15	22	11	11	15	4	15	2	17	11	15	13	24	10	10	3	14	19	18	12·2
	10	13	8	11	13	11	22	20	14	12	15	9	15	6	16	13	15	16	26	13	13	3	10	15	20	13·7
	11	13	10	10	15	15	24	22	13	11	17	12	19	8	18	11	12	17	28	13	10	4	8	18	17	14·4
	12	14	12	10	15	16	30	19	15	12	14	14	17	8	20	14	15	20	23	10	9	4	12	16	18	14·9
P. M.	1	12	10	12	15	19	22	16	15	12	15	14	16	11	19	15	11	19	25	8	9	6	12	16	18	14·5
	2	14	12	14	16	20	25	18	18	11	12	11	17	10	20	12	11	19	26	6	9	8	12	19	17	14·9
	3	13	13	11	20	19	20	13	15	12	13	8	13	6	22	12	9	18	22	7	12	9	11	19	13	13·7
	4	13	14	9	20	17	19	15	8	8	11	7	15	6	16	10	10	18	22	6	11	7	11	19	11	12·6
	5	10	14	10	19	15	19	14	8	6	6	9	11	10	19	6	10	15	19	5	5	6	8	16	9	11·2
	6	7	16	6	16	10	19	11	8	5	7	6	10	10	21	5	10	11	17	2	6	5	7	13	3	9·6
	7	4	17	4	11	13	17	10	5	4	3	6	7	5	21	4	7	7	17	3	3	11	6	12	5	8·4
	8	5	18	1	13	2	18	10	2	5	5	7	6	5	19	3	5	9	19	4	4	12	7	15	2	8·2
	9	4	17	0	13	6	15	6	4	4	6	11	8	6	14	6	3	12	16	9	2	10	4	15	2	8·0
	10	2	17	2	17	7	20	5	5	4	6	20	3	4	9	6	6	15	15	9	2	11	7	11	5	8·7
	11	2	17	2	20	3	15	5	5	4	3	17	4	5	8	6	6	14	8	5	3	12	6	9	2	7·5
	12																									
Total Daily Movement.		175	211	233	283	268	394	355	182	149	238	172	288	123	322	225	207	298	476	197	198	145	254	325	258	10·4

The Anemometer was dismounted on the 25th, for the purpose of erecting a new instrument on the pattern decided upon for the Board of Trade observatories.

NOVEL ACTION OF LIGHT.

BY NIEPCE DE ST. VICTOR.

(Translated from "Comptes Rendus," No. 12, 1867).

I HAVE published, in five preceding memoirs all the experiments which I have made to prove that porous or rough bodies which have been acted upon by light preserve an activity capable of reducing salts of silver in the dark, as though they had been exposed to light. I have shown that this *activity* is persistent; that it is preserved for many days in obscurity or in the free air; that if a body had lost this activity, it could be made to resume it on exposing it again to light; that, supposing a piece of cardboard, was insolated, having been impregnated with nitrate of uranium, or tartaric acid, and shut up in a confined atmosphere, such as a tin case, hermetically sealed, it would have the same activity after several months as it showed on the first day.

This activity acts at a certain distance in the dark, for instance, and is communicated to a similar body in the same way, but the action does not pass through the glass.

M. Arnaudon, a chemist of Turin, has repeated some of my experiments in different gases, and the results have been the same as in free air. It would be very important to make an experiment in a luminous vacuum, but I have not as yet been able to do it. I proved the production of this activity upon the edges of a newly-broken china-plate, as well as upon an unpolished sheet of glass, made perfectly clean with distilled water. It could not be said, therefore, in this case, that there was decomposition of the body acted upon by light. I have shown that the effects of light are not owing to phosphorescence, but I have not said whence this activity comes. Many hypotheses have been put forward. Certain persons have denied the fact altogether, which was more simple; but no one has given a solution to this phenomenon. I said, in my first memoir, that an engraving or a plain sheet of paper having been insolated and afterwards placed on a layer made sensitive to light, such as iodide or chloride of silver, reduces salts of silver in obscurity, as though they had been exposed to light, only much more rapidly. If the sheet is impregnated with nitrate of uranium, or tartaric acid, before being exposed to the light, the reduction of the salts of silver is very quick, especially with the first substance.

This is, then, my experiment. I placed seven strips of red, orange, yellow, green, blue, indigo and violet glass

upon a sheet of paper. After insolation, I have applied this sheet of paper to another sheet covered with iodide or chloride of silver, and have then left them in contact, in the dark, for twelve hours. I then saw that the bands of red, orange, yellow and green glass, had not made any impression on the sensitive paper, while the blue, indigo, and violet bands had darkened it. I repeated this experiment upon paper or cardboard impregnated with nitrate of uranium, or tartaric acid; the sensitive layer was much more coloured in the parts corresponding to the same rays than I have indicated above. When the sheet of paper containing nitrate of uranium, or tartaric acid, has been insolated, this activity can be easily proved by pouring a solution of nitrate of silver, in form of a train, upon the insolated part. A very strong colouring is immediately seen in the blue, indigo, and violet rays, and not any in the four first, except the exposition to light has been very much prolonged. In this case a slight colouring is seen in the green, yellow, and red rays, but not any in the orange. If bands of glass are placed on a sheet of gummed paper, and it is exposed for about an hour to solar light, on pouring a solution of iodide of potassium on the part covered with the seven bands of glass, the parts of the paper corresponding to the violet, indigo, and blue rays, would be observed to take a brick-red tint, while the green, yellow, orange, and red rays would remain unchanged.

If an iodide of silver is formed by pouring on nitrate of silver before the iodide of potassium, in the dark, the iodide of silver would be coloured in the most refrangible rays. By this means a sheet of paper can be insolated under a press, and a positive proof obtained in the dark, which can be strengthened by means of sulphate of iron. I ought also to mention, that I have made experiments with coloured glasses upon white and coloured stuffs, and the stuffs and the colours were only altered by the light under the violet, indigo, and blue glasses. I should say that light has less action under a violet than a white glass, and less under the latter than in open daylight.

Conclusions.—After these experiments, it can be said that light has only a destructive action in the most refrangible rays. That is known, it will be said; but this *persistent activity* was not known before my experiments, and now I demonstrate that it is owing to chemical rays, and that it has the same effect as direct light in reducing salts of silver.

ARCHÆOLOGIA.

In our July number of the Intellectual Observer, we gave an account of the discovery of what we believe to be the Roman Station of Vindomis, in the neighbourhood of Andover; and we have to add that further discoveries have since been made near the same place. The Rev. E. Kell and Mr. C. Lockhart, to whom we owe these former discoveries, believed that other remains existed in connection with them; and, on Monday, the 16th of September last, they were successful in their search. The foundations of a second Roman building were discovered in the same Castle Field, at the distance of 256 feet to the westward of the one excavated in May last. This new discovery is as yet of small extent; the four labourers employed uncovered the foundations of a wall three feet thick, composed of faced flints, for a distance of fifteen feet only; but there can be no doubt that it extended much further, and that, in fact, it forms part of some considerable building. What relation this may have to the building formerly excavated, it is impossible, with our yet imperfect knowledge, to conjecture. Among the antiquarian relics found in the course of the excavations were a Roman coin, third brass, of one of the Constantine family; numerous fragments of pottery; pieces of stone roof-flags, which showed that it was the wall of a building which had had a roof; iron nails; some oyster-shells; and bones and teeth of the ox, pig, etc. The farmer of the land, Mr. Turner, was unable to allow any complete examination of this new building to be made on the present occasion, as it was necessary to occupy the land immediately for agricultural purposes; but he has promised to allow the exploration to be continued in the autumn of 1868.

The Rev. Canon Greenwell is indefatigable in his researches among the Yorkshire Barrows. He has recently opened a group of seven, in the vicinity of Weaverthorpe, on the range of hills between Malton and Filey, two of which were very remarkable for the objects found in them. They were all of low elevation, from one to three feet; but this was perhaps the mere effect of time. The first of the two alluded to was two feet high by twenty-two in diameter. A skeleton, judged to be that of a female, lay on its left side, doubled up, in the centre, on the natural surface of the ground. On the right wrist was a beautiful bronze armlet, of the snake-head pattern, and a succession of oval swellings lengthwise. Close to the neck was a delicate bronze fibula, of the bow shape, extremely elegant in workmanship. It had originally a tongue of the same metal, which had been broken off, and replaced by an iron tongue. On the chest lay a necklace of extremely beautiful beads, fifty-two of glass and seventeen of amber. The glass beads, with one exception, were blue in colour, and ornamented with a zigzag pattern in white enamel; the exceptional bead being larger and more globular, and ornamented with amulets of white. Much broken pottery was found in the mound, with a few flint-chippings. The other barrow

was only one foot high by twenty-seven feet in diameter, and in the centre lay, on the surface of the ground, a female skeleton, also doubled up and laid on her left side. The right wrist, as in the former case, was encircled by a bronze armlet. It is described as being "of the most beautiful description, resembling a delicately-formed cog-wheel, with rounded teeth on both sides, the rim between the teeth being ornamented with three grooved lines. For exquisite preservation, delicacy and beauty of workmanship, high polish, and brilliant patina, this armlet is not to be surpassed." Below the hip were the remains of a plain urn "of a peculiar dark-coloured ware." A hole, or trench, in this tumulus, contained flint-chippings, animal bones, charcoal, and fragments of dark-coloured pottery. The rest of the barrows contained no very remarkable objects; in one only there were the fragments of a highly ornamented drinking-cup. We cannot quite see the evidence on which the writer of the local reports considers these barrows to belong to the late Celtic period, and why they are fixed at a date about one or two centuries before our era. We have given the description of the objects found in the two principal tumuli from the accounts published in the local papers, and it would be necessary to see them before forming any certain opinion; but, from the description, we should ourselves hardly judge them to be pre-Roman. In a cemetery at Seamer, in this same district, opened by Lord Londesborough in 1857, which was undoubtedly of the Anglo-Saxon period, probably of the fifth or sixth century after Christ, the body in one grave lay on its side, doubled up much as described above. An account of it has since been published in the "Journal of the Archæological Association"; and we believe that, in the only other grave opened on that occasion, in which nothing but a skeleton was found, it lay in exactly the same position.

We have just received a new proof of the archæological activity and knowledge of Mr. Ecroyd Smith, in a pamphlet entitled, "Archæology of the Mersey District," 1866, reprinted from the "Transactions of the Historic Society of Lancashire and Cheshire," and containing much interesting matter. Perhaps the most interesting article in it is one which seems to fix the position of a ROMAN STATION which has been hitherto doubtful. It appears, from the second and tenth Iters of Antoninus, that a Roman road from *Deva* (Chester) entered the road which ran from *Mancunium* (Manchester) to *Mediolanum* (supposed now to be Middlewich, in the centre of Cheshire), at a spot where there stood a town or station named CONDATE. Several localities have been put forward as the site of this place, but with not very satisfactory reasons. It has now, however, been discovered, by very recent diggings for sand, that numerous Roman antiquities are found at a place named Wilderspool, near Warrington, which answers to the Condate of the Itineraries in a very satisfactory manner; and, as we understand, appears, from other circumstances, to occupy the spot where the two roads met. The works, in the course of which the Roman antiquities are brought to light, are carried on in the present year with activity which promises important results. We owe this identifica-

tion to Dr. Robson, of Warrington; and Dr. Kendrick, who has watched the discoveries at Wilderspool, promises a full account of them for the next volume of Transactions of the "Historic Society."

The latter part of Mr. Ecroyd Smith's pamphlet is occupied by his report of the archæological produce of THE CHESHIRE COAST during the year 1866, in continuation of a former report, of which we have given an account before (INTELLECTUAL OBSERVER for May, 1867). Of the objects thus found, Mr. Smith has given a classed list, descriptive when necessary, with engravings of a few of the more interesting objects found. Under the head of Primeval, he enumerates twenty-one rudely-fashioned implements of flint and limestone, an arrow-head of bone, and a curious skewer, or pin, made of whalebone. To the Roman period belong four Roman coins (the only three which are legible belonging to the Emperors Nero, Antoninus Pius, and Probus); a key; a fibula of the bow shape; an *acus*, or pin, of a brooch; two dress pins, or (as they are usually called, perhaps in this case less correctly) hair-pins; and a piece of hæmatite, which Mr. Smith supposes to have been used as an amulet. The Saxon period is only represented in this list by two glass beads, of a pale straw colour. The objects here classed under the head of Early English, and which would perhaps be better described as Mediæval, are so numerous and so varied in their material and character that we cannot attempt to enumerate them. A few relics of less interest, and dating from the reign of Elizabeth to the eighteenth century, but belonging principally to the seventeenth, are classed under the head of Later English. The total number of objects of archæological interest, irrespective of animal remains, found in or near the sea-beach of Cheshire during the year 1866, amounts to 238.

The new EXCAVATIONS AT WROXETER (Uriconium), though interrupted for a while by the necessity of employing the men in the labours of harvest, have produced some very interesting results, of which we intend to give a more full account on an early occasion. The new room opened, adjoining to what was named the enameller's shop, and, like it, facing the Roman forum, proves to be another shop, of exactly similar dimensions and character. It is singular that two large workshops, evidently for the manufacture of small ornaments in metal, should stand side by side in such a position; and we may almost suspect that Uriconium was a great manufacturing town—a Birmingham of Roman Britain. Future researches will, no doubt, throw more light on this question. Among the numerous relics recently discovered, was a pretty intaglio, engraved in a bright red cornelian, and representing two parrots, seated on what appear to be two vessels, with a large vase between them, into which what bears resemblance to a stream of liquid flows from their mouths. We regret to say that, just as this object was carried to the Museum, some visitors who happened to be there were allowed to take it in their hands to examine, that it quickly disappeared, and that nobody has heard of it since. Fortunately, impressions had been taken in wax; but it cannot but be

believed that, whoever has it in his possession, will soon see the propriety of returning it to its right place in the Shrewsbury Museum.

We would call attention to a very ingenious and probably correct suggestion made by Mr. Roach Smith, in his Notes in the last number of the "Gentleman's Magazine." Every one at all acquainted with the Roman antiquities of our island, knows how frequently large HOARDS OF ROMAN COINS are found buried in the ground. The Anglo-Saxons had remarked this circumstance, but they imagined that the Romans, when they left the island altogether, nourished the hope of coming back again, and that they buried their treasures, in the idea they would thus be preserved till their return. It is a remarkable circumstance, that nearly all these hoards contain almost the same proportions of the coins of the different emperors; that the most numerous are those of Tetricus, father and son, and that the least numerous are those of Aurelian, with whom they almost all conclude. Mr. Roach Smith compares two hoards recently discovered, one at Netly in Hampshire, the other in Yorkshire, and therefore in widely distant parts of the island. In the former, consisting in all of 1821 coins, there were 749 of Tetricus the father, 255 of Tetricus the son, and one of Aurelian; in the latter, out of a total of 3095 coins, there were 1097 of Tetricus the father, 434 of Tetricus the son, and four of Aurelian. Mr. Roach Smith conjectures, and we are quite of his opinion, that when, at that eventful period in the history of the Roman empire in the west, the legions in Britain and Gaul, who had supported the usurpation of Tetricus, were called into the latter province to oppose the advance of Aurelian, the soldiers of the legions in Britain, before their departure, buried these hoards, and that the owners never returned to reclaim them, being slaughtered probably in the great battle which restored the western provinces to the empire of Rome. A comparison of these hoards is further interesting to us, as it shows us the proportions of the coinage of the different emperors in circulation at the close of the third century.

T. W.

PROGRESS OF INVENTION.

ARTIFICIAL MEERSCHAUM, ETC.—Chemistry has discovered a new and interesting use for potatoes and other vegetables, illustrations of which are now to be seen at the Paris International Exhibition. If potatoes are peeled, macerated for about thirty-six hours in water, to which eight per cent. sulphuric acid has been added, well washed with water, dried in blotting-paper, and then in hot sand for several days, on plates of chalk or plaster of paris, which are changed daily, being compressed at the same time, an excellent imitation of meerchaum, answering well for the carver, or any purpose not requiring a high temperature, will be obtained. Greater hardness, whiteness, and elasticity will be produced if water containing three per cent. of

soda, instead of eight per cent. sulphuric acid is used. And if, after the potatoes have been macerated in the solution of soda, they are boiled in a solution containing nineteen per cent. soda, a substance resembling stags horn, and which may be used for knife handles, etc., will be formed. Turnips may be used instead of potatoes in the production of the artificial horn; and if carrots are substituted for the potatoes, a very excellent artificial coral will be obtained.

Railway Safety Switch.—It is of the utmost importance that the points on railways should be in the proper position. If they are not, a train may run on the wrong line, and thus destructive collisions ensue. Such has been but too often the cause of serious accidents, and great mischief to both life and property. The pointsman may be neglectful, or over-fatigue may cause him to forget his duty. Hitherto there were no effective means of discovering the circumstance until it was too late. A very ingenious and simple application of electricity now renders it extremely easy. The switch is so arranged that, whenever it is not in a proper position, it completes the electric circuit of a galvanic battery, and the current thus set in motion operates on an electro-magnetic apparatus, which keeps an alarm bell ringing where it cannot but draw the attention of responsible persons to the pointsman's neglect, so that the switch may be put in its proper position before any injury is done.

Manufacture of Starch.—An improvement of considerable importance has recently been made in the manufacture of starch. It is founded on the fact that, although the specific gravities of the starch and of the substances associated with it in the grain, etc., from which it is extracted are very nearly, they are not quite the same; and the improvements, which is due to M. L. Maighe, consists in an ingenious application of centrifugal force. Water is added to the crude starch in the proportion of two parts of the former to one of the latter, and the mixture is introduced into a copper drum which is capable of making some hundreds of revolutions per minute. As soon as the proper velocity has been reached, the starch, having a greater specific gravity than the water, and therefore being more affected by centrifugal force, is driven with such violence against the circumference of the drum that it forms a solid mass of great whiteness and purity, being entirely separated from the other substances, which remain suspended in the water. This method of obtaining pure starch has peculiar advantages: it requires only a few minutes, while the ordinary process takes several weeks; it is more economical, since with it the yield is twenty per cent. greater, and hence starch may be profitably manufactured from other matters besides wheat, which from its nutritious qualities should be as far as possible kept for food; and, finally the cellular tissue, gluten, etc., which are very valuable, but by the ordinary modes of manufacture almost entirely go to waste, may be utilized. It is not improbable that a similar application of centrifugal force might be advantageously applied to the separation of other substances differing but little in specific gravity.

A NEW BLASTING POWDER.—Vast quantities of explosive material are now used in the operation of blasting; and hence numerous attempts have been made to discover new and better explosive compounds than gunpowder. The efforts which have been made in this direction have not, as the discovery of nitro-glycerine attests, been without success. The dangerous nature of that substance, however greatly limits its utility. Wilhelm and Ernst Fehleisen have formed a compound which is in several respects superior to any of the explosive materials hitherto used. It cleaves, rather than blows into atoms: an important quality, especially when it is employed in the coal mine. It does not ignite spontaneously, nor is it set on fire by friction or percussion. Its combustion gives rise to no opaque, nor suffocating gases, which makes it very valuable in the operations of tunnelling. It has but one disadvantage: weight for weight, it is twice as bulky as gunpowder; but even this is in a great measure compensated by the fact that it is one-half more powerful. It is formed by thoroughly mixing nine parts by weight saw-dust obtained from a light and non-resinous wood, or wood from which the resin has been extracted, from three to five parts charcoal, and forty-five parts saltpetre, and, if required to be quick, one part ferrocyanide of potassium; the mixture being moistened with one quart of water to every hundred weight. It is granulated by stamping or crushing, and the grains may be polished in the ordinary way; this, however, will merely improve the appearance without increasing the explosive power. This compound has been termed *Haloxylin*.

THE COLOURS OF THE STARS.—The determination of the precise tints of the stars is not only a matter of interest but importance; and an instrument for this purpose has recently been invented. The object proposed by the inventor was to compare the tint of the star to be examined with that of a solution, the colour of which is known. For this purpose, a platinum wire is rendered incandescent by means of two elements of a Smee's battery; and the rays of the artificial star, thus produced, are made to pass through small phials, filled with solutions of known tints, and attached to a drum which has radial openings, and is capable of revolving, after which, they pass into the objective of a small telescope. The artificial and the real star are compared; the drum being turned until the rays from the incandescent platinum appear of the same tint as those from the star. When the tints are the same, it is known that the proper solution has been used, and the tint of this solution being known, the colour of the star is found.

MAGNETISM AND THE METEORITES.—From the fact that meteorites consist invariably and almost exclusively of nickel and iron, it might, at first, be concluded that the small planetary bodies which are now known to circulate in such numbers in orbits intersected by the orbit of our earth, especially in August and November, consist only of these metals. But the conclusion would not be legitimate, if it be true, as there is reason to believe, that gravitation is not the only force which causes meteorites to be precipitated on our earth. It is remarkable

that the constituents of meteorites are iron and nickel, two eminently magnetic metals. And it is not improbable that gravity is aided by magnetism, in attracting these bodies to the earth. Only bodies, therefore, containing iron and nickel reach us, because gravity unassisted by magnetic attraction is unable to draw bodies otherwise constituted out of their orbits.

Steam applied to Railway Breaks.—The safety of a train not unfrequently depends on the power of quickly bringing it to a state of rest. This can be effected only by breaks. The more rapidly, therefore, and powerfully these can be brought into action the more they contribute to the safety of the train. Manual power, to be at all effective, must be slow; and hence, independently of its being very limited in amount, an accident may occur before it has had sufficient time to come properly into play. Steam therefore is now being substituted in America for the muscular power of the breaksman, and with most excellent effect. A steam cylinder of small bore, but of considerable stroke is placed in the locomotive, under the driver's foot board. The steam is turned on or off this cylinder, by means of a handle which projects through the foot board. A chain which acts on all the breaks of the train is attached to the extremity of the piston rod. The pressure is never allowed to become so great as to cause the wheels to slide, that in the cylinder being regulated by a safety valve attached to it. The power which may be given to such a break is practically unlimited. That with which the experiments were tried was capable of exerting a force of three thousand five hundred pounds; and of stopping within a space of seven hundred feet, a train moving at the rate of fifty-six miles an hour.

New Preservative Compound.—Many substances have been employed for the preservation of animal matters, and with greater or less success. Most of them are, however, liable to the objection of difficult application or expense. A compound which is cheap and easily applied, and is very effective, especially in the preservation of anatomical specimens, has recently been discovered. It is made by adding to about fourteen parts glycerine, two parts brown sugar, and one part nitre; the addition of the sugar and nitre being discontinued as soon as a slight deposit begins to be formed. Immersion in this fluid for a number of days, dependent on the size of the object to be preserved, effectually preserves organic substances from putrefaction, without, at the same time, altering their appearance. When first lifted out they will indeed, be in the highest degree rigid, but on being placed for a while in a warm dry place they will become as pliant as ever.

New Explosive Compound.—Experiments made on the effects produced by nitrate or chlorate of potash on glue have led to the discovery of a new and extremely cheap explosive compound, which may be employed with special advantage in conjunction with ordinary gunpowder. This compound may be obtained by either of two methods. According to one of them, two parts glue are washed with cold water; then heated moderately with a small quantity of nitric acid, evaporated, again mixed with water, and freed from

acid by carbonate of baryta, not in excess: again evaporated to dryness, mixed with one part sulphur, then with water, and next with six parts nitrate of potash. According to the other method, the glue having been melted in warm water, half the nitrate of potash and then the sulphur are added to it. It is then heated until it assumes a uniform appearance, on which the rest of the nitrate is added. The compound obtained by either of these methods is neither deliquescent nor hydroscopic; but being made with nitrate instead of chlorate, unless mixed with ordinary gunpowder it burns slowly and without explosion. If mixed with five parts gunpowder it forms a cheap and powerful explosive agent. It is applicable, advantageously, in the formation of fire-works: and when mixed with the appropriate substances, it affords brilliantly coloured fires.

New Application of Photography.—Photography is now being applied to the registration of the pulsations of the heart and arteries, a purpose eminently useful to the physician. The apparatus employed consists of a glass tube, that at one end is widened out into a cone, the base of which is closed with a thin membrane of vulcanized india-rubber. The upper extremity of the tube is inserted in the slit formed in a division placed in a small camera about its middle and at right angles to its length; the slit being capable of being closed or opened at pleasure, by means of a small moveable screen. The sensitized plate is made to move with a regulated speed by clockwork. When an experiment is to be made, so much mercury is placed in the tube that it will rise to some portion of the slit, within the camera; and the membrane is laid on the heart or the artery the pulsations of which are to be recorded. Every pulsation disturbs the level of the mercury in the upper part of the tube; and as light can pass to the sensitive plate only through the tube, a picture having an undulating lower margin is formed. The sensitized plate moves at the rate of one centimetre per second; but the effect is magnified so that the curve representing it has an extent of fifteen centimetres. The rate and energy of the pulsations of the heart or of any artery is in this way accurately and satisfactorily recorded.

LITERARY NOTICES.

The Theories of Copernicus and Ptolemy. By a Wrangler. *Longmans.*—No proposition, however well established, ought to escape a frequent re-examination, as the development of the human mind is not promoted by the reception of any doctrine, however true, merely upon authority, but rather by a constant search after truth, through the collection of facts, and the operations of reason thereupon. Whatever is taught upon authority only, should be held as a matter for provisional acceptance only, and not advanced higher, until the inquirer has been able to discover or follow the train of reasoning

by which it is established. In the absence of any sufficient original investigation into the grounds upon which any proposition that receives the sanction of authority rests, the authority, if supposed trustworthy, affords a convenient resting place, and establishes in the mind of every one who thinks it more likely to be right than wrong, a certain balance of evidence in favour of the proposition it affirms. The evidence is, however, of this character—Smith is an intelligent man—he has studied the subject,—he says so, and he is likely to be right. True, but he is also likely in a greater or less degree to be wrong. A high degree of probability is all that we can expect to attain to; but after the probableness of a statement reaches a certain point, it becomes reasonable to act upon it, and to regard it as true, but faith in the most probable statement should never hinder the perception of the improbability, however small it may be, that remains attached to it, and which cannot be regarded as a constant and ascertained quantity, but must be esteemed as a quantity which further discovery may at any time change the value of, either in the direction of its augmentation or its diminution.

The "Wrangler" who puts forth the pamphlet on the "Theories of Copernicus and Ptolemy," deserves the thanks of those who recognize the truth of the propositions we have thus sketched out. It is no doubt common to assume that the Copernican theory rests upon a more thoroughly complete mass of evidence than can be claimed for it; but its defenders are only bound to show that, as compared with the Ptolemaic theory it is sustained not only by a balance of probability, but by enough probability to be a legitimate basis for thought and action. That the conception of gravitation as an universal force, resident in, or essential to, all matter, and causing all particles to attract each other proportionably to their mass, and in an inverse proportion to their distance, could not be maintained by anything like proof. Astronomers have to recognise repulsive forces as well as attractive ones, and we know of no argument in favour of the supposition that the attraction of gravitation is not correlative with any other mode of force, but always existing without change as an absolute property of each particle of matter, and in eternal antagonism to all repellant forces. Views of this kind have been several times put forward in our pages.

The "Wrangler" contends, not for the truth of Ptolemaic astronomy, but that its major requirements are not improbable, and it is here that most philosophers will disagree with him, and we are not sure that he sufficiently recognises the evidence of improbability that attaches to the best proved systems, or sufficiently admits that some amount of improbability is no ground for disbelief. It is important, however, to bear in mind the doubts and objections of the "Wrangler," which are well put, though not, it strikes us, at all new. Our solar system may be but a portion of a greater system, and the centre of gravity of the whole may be nearer or further than astronomers fancy. This will be generally admitted, so will the analogy between the particles of a small body, and that of sun and the planets regarded as particles of the giant whole. The constitution of nebulæ, the appearance of a repulsive

action in the sun on cometary matter, and other facts adduced by the "Wrangler," all point to the conclusion that the laws we are acquainted with do not explain the whole system or cosmos. As the "Wrangler's" paper is only a pamphlet of fifty-six pages, we abstain from extracts, merely recommending it to the notice of those who like to see inquiry stimulated, and the best established beliefs re-examined from time to time.

NOTES AND MEMORANDA.

THE COLOUR OF WATER.—Father Secchi, in a paper on "Star Spectra," in "Comptes Rendus" (1867, No. 14), says: "Having ascertained that the spectrum of sea-water is destitute of red at small depths, and of yellow and green—at least of their greater part—at successively greater depths, at which the water has a blue or violet colour, I wished to see if the same absorptions were exhibited in glaciers. Profiting by the incident of an artificial grotto having been dug in the glacier of Grindelwald, I made some experiments on this subject. The grotto in question is about 100 metres deep, its walls are transparent, and illuminated by sunshine passing through the ice. This light has a fine blue tint, in which the red is extremely weak, so that in the grotto human faces have a frightfully cadaverous aspect. Looking from a certain depth in this grotto back towards the entrance, the light there appears red, owing to the effect of contrast. A spectroscopic examination shows the light in the grotto to be almost deprived of red, and to have the yellow greatly diminished. The thickness of the ice is not sufficient to produce a more complete absorption. It is said to be about fifteen metres thick, but I should say less. The ice is perfectly compact and continuous in its texture. It is limpid as crystal, and contains here and there groups of air bubbles. Its hardness is not great; an iron point easily penetrates it. The result is thus identical with that which is obtained with sea-water at similar depths; and as in the Alpine ice we cannot suppose the presence of extraneous colouring matter that might be presumed to exist in the sea, it follows that the true colour of water is a blue mixed with violet, which grows darker as the thickness traversed by the light increases."

SULPHURIC ACID FORMED BY A MOLLUSK.—M. M. S. de Lucca and P. Panceri state, in "Comptes Rendus" (1867, No. 14), that the salivary organs of the *Dolium galea* secrete a fluid which contains more than three per cent. of sulphuric acid. They examined two specimens caught in the Gulf of Pozzuoles. When filled with liquid, the glands, two in number, are larger than ordinary fowls' eggs, and weigh about seventy grammes. They are formed of two distinct parts—one small and opaque, close to the excretory orifice of the gland; the other large and transparent, the membrane enveloping it being very thin and white. When incisions are made, so that the lower part of the gland comes in contact with the air, gaseous bubbles of pure carbonic acid are disengaged from the *cul de sac* tubes, of which almost all the gland is composed. A gland weighing seventy-five grammes discharged under water 200 cubic centimetres of carbonic acid. The liquid contained in the gland tastes like lemon juice, acts on marble, and changes the colour of litmus. A series of experiments show it to contain sulphuric acid. It was previously known that the *Dolium galea* ejected an acid liquid from its mouth which effervesced with carbonates, and when analysed by M. Bædeker, gave 2·7 per cent. of sulphuric acid. The authors of the paper state that they will continue their researches with a view to discover how the sulphuric acid is produced, and what function it performs in the economy of the animal. They say this *Dolium* "is the first animal which they knew of capable of making sulphuric acid by an unknown process."

THE COLOUR QUESTION AND THE LUNAR ECLIPSE, SEPT. 13TH.—Referring to the accounts of this eclipse we published in our last number, we may say that

several observers besides Mr. Browning speak of absence of colour. M. Chacornac states the contrary. He says the greater part of the lunar disk plunged into the shade of the earth was of a red colour, the portion near the limit of the shadow slightly violet. Between these two extremes, yellow, orange, green, and blue exist, resulting from the decomposition of solar light by refraction of the terrestrial atmosphere. Mr. Huggins informs us that excess of light prevents a proper view of colour, and Mr. Knott has found too much light to interfere with a just appreciation of the tints of double stars. M. Chacornac's observations were made at Ville-Urbanne, but he does not say with what aperture. He has the large Foucault reflector there. The "Monthly Notices" contain Mr. Weston's observations made at Endsleigh Observatory, Bath. He describes the prevailing colour as "red-bluish and grey, and grey. The redness increased towards the *darkened edge* of the moon. He did not notice this colour at "the boundary line when the earth's shadow impinges on the moon; but, on the contrary, it was confined to the *opposite* eclipsed region, darkening as it approached the northern parts, and attaining the greatest depth at the moon's periphery. . . . That these effects did not result from any chromatic errors was proved by using different telescopes and powers. The colour and their relative positions differed entirely from those presented in the partial eclipse of Feb., 1858."

Two New Planets, (93) and (94).—Mr. Watson, of Ann-Arbor, states in the "Astronomische Nachrichten," that he discovered the first of these bodies on the 24th August, and the second on the 6th Sept. Both are of 11 mag.

Micro-crystals of Alkaloids.—At the meeting of the Royal Microscopical Society, on the 9th Oct., Dr. Guy read a long paper on crystallizations and arborescent forms obtained by subliming minute quantities of strychnine and other alkaloids in the manner originally proposed by Helwig. Dr. Guy's process is to place the matter to be sublimed at the bottom of a small flat porcelain vessel, such as a crucible cover. Over it he puts a square of glass, about one-eighth of an inch thick, with a round hole in the middle. Over this hole he places a flat piece of glass. A moderate heat, carefully applied by a spirit lamp, sublimes the alkaloid, and it is condensed on the plate of flat glass, and ready for microscopic examination. Quantities such as the 10,000th part of a grain give satisfactory results. Many photographs of crystallizations, exhibited by Dr. Guy, were of great beauty. Evidence of this kind might be important in medico-legal inquiries, but it could scarcely be regarded as conclusive, though it might form part of a conclusive chain of proof.

The Coming Star Showers.—Our readers should refer to the important paper by Mr. Proctor, in our last number, on this subject, before the arrival of the 14th. At a quarter past six on the morning of the 14th may be the maximum, but the meteors should be looked for some hours earlier to prevent disappointment.

A Waistcoat-pocket Microscope.—The most elegant and convenient portable microscope is one devised by Mr. Highley, on the plan of the class microscopes introduced by Dr. Lionel Beale. Mr. Highley's instrument fits into a German silver case, rather less than four inches long and five-eights of an inch wide. It is furnished with a live-box, draw-tube, eye-piece, and dividing objective. Its power is sufficient to show the nature of urinary deposits and other morbid products; and as a field instrument for the collector of diatoms, desmids, minute algæ, etc., it will be highly esteemed.

W. F. Maples, del.

INSECT EGGS.